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Açılış Konuşmacıları ve  
Davetli Konuşmacılar  
Özet Kitapçığı

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Prof. Dr. Hasan MANDAL  
TÜBİTAK

"2023'e Doğru TÜBİTAK ile Geleceğe Bakış

Dr. Davut UZUN  
TÜBİTAK

"Lityum İyon Pilleri ve Elektrikli Araçlar: Türkiye'nin Potansiyeli"

**Professor Neville Assad-Salha (Australia)****KEYNOTE SPEECH SUMMARY**

The Seres '18 Exhibitions are a role model for the world.

They comprise of an extreme diversity of different professional approaches through the material, Clay.

It is wonderful to see these exhibitions broken up into 3 major themes: -

“Fantastic Teapot”; “Ceramic Jewelry” and “Old & New” which includes glass artists. These exhibitions give ceramic and glass artists an opportunity to explore different areas and perceptions through their medium.

The Turkish educational and wider ceramic community is rapidly becoming a leading role-model as it incorporates many different approaches and theories behind the education of ceramics.

The Symposiums have given the opportunity to many international artists to come to Turkey and absorb the rich culture that it has to offer, in turn creating influence throughout the world.

We can see wonderful crossovers and inspirations happening through many different cultures.

Since the 8<sup>th</sup> Century, Turkey has been a leading force in paving the way in ceramics and adapting ceramics into functionality and aesthetic form which has given a great deal of influence to contemporary ceramics throughout the world.

We have seen clay going from a strong position in the Arts in the 1960's and '70's to a lesser position in later decades, and now has returned to a major platform which is currently in a very strong position in the art world. This is wonderful to see as it is now giving many of the younger members of the community the opportunity to express themselves through a malleable material.

It also allows established clay workers to reposition themselves in the art world and re-explore a range of approaches which feeds back into the educational departments in Ceramics etc.

Ceramics currently has gone into many different areas from the most simplistic and minimal forms to the more rugged, organic and robust artworks.

It has also allowed the artist to move into the most decorative forms, along with conceptualizing through the material, Clay.

The Macsabal Symposiums which have taken place over the past 20 years in Korea, Turkey and China, have proved to be extremely successful in bringing international artists together from many different countries and influences within the medium of ceramics.

Finally, exhibitions of this kind advance the global field as to how we see and move forward with contemporary ceramics.

Thanks to the Turkish Ceramic Society and Anadolu University for organizing these 3 major international Seres18 Exhibitions.

Thanks to the International Macsabal Symposium organized in 3 countries, including Ankara, Turkey; China and Korea.

Also thanks to the International Terracotta Symposium in Eskişehir, the Mayor of Eskişehir Municipality and his council members for their continued support.

These symposiums are the intersection point for the meeting of the artists in the world.

Finally, a special thanks to Lecturer Mutlu Baskaya and her committee.



## Davetli Konuşmacılar (Bilimsel)



## Ceramic Nanocomposite Negative Electrodes for Li-ion Batteries

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### ABSTRACT

Electrochemical energy storage has become a critical technology for a variety of applications, including grid storage, electric vehicles, and portable electronic devices. Ceramic based anodes ( $\text{SiO}_x$ ,  $\text{GeO}$ ,  $\text{SnO}_2$ ,  $\text{ZnO}$ ,  $\text{Fe}_2\text{O}_3$  or more complex stoichiometry, etc.) have much higher Li storage capacity than the intercalation-type graphite anode that is currently used in Li-ion batteries (LIBs). Almost all the ceramic based or ceramic supported negative electrodes are considered as a promising anode material for rechargeable LIB, owing to their high theoretical specific capacity. Despite the low capacity, graphite anodes still dominate the marketplace due to the fact that alloy anodes have two major challenges that have prevented their widespread use. However, the practical implementation of metal (M) and metal oxide (MO) anodes is still blocked due to three major problems [1]: poor cycle-life results from pulverization during the huge volumetric fluctuations ( $>300\%$ ), drastic irreversible capacity loss and low coulombic efficiency, the solid electrolyte interphase (SEI) breaks as the nanostructure shrinks during delithiation. This results in the exposure of the fresh MO or similar active material surfaces to the electrolyte and the reformation of the SEI, resulting in the SEI growing thicker with each charge/discharge cycle and highly possible particle aggregation [2]. The critical issue of fabricating high specific capacity, high rate capability, and long cycle life LIB device is the advanced nano architected design and flexible electrode materials with good mechanical deformations. Nanocomposite structures are pivotal for the progresses in electrode materials due to their manageable surface-area, stunted mass and charge-diffusion span, and volume change acclimatization during charging/discharging. CNTs, CNFs and Graphene with their special structures provide excellent conductivity, mechanical flexibility and significantly large surface-area, are considered ideal additives to enrich chemistry of electrodes [3].

In order to prevent these challenges, most common and effective strategy to adopt nanoscale materials with various morphologies, including nanoparticles and, nanowires, nanotubes and hollow spheres. Compared to bulk active materials, such nanostructured ceramic based oxides, nitrides and carbides are able to accommodate elevated mechanical stress, resulting in prolonged cycling stability. Optimization of ceramic based electrodes can be achieved by incorporating nano structures with various conductive matrixes, such as graphene and, carbon nanotubes, and carbon and to form core-shell and yolk-shell nanocomposites. The introduction of such a carbon architectures with ceramic phases play a key role in alleviating the agglomeration of nano structured active materials [4]. In this review, we summarized the recent progresses on developments of ceramic based nanocarbon supported (CNT, CNF, Graphene etc.) negative electrodes for high performance Li-ion batteries. The synthesis techniques of the 1-D, 2-D and 3-D electrodes has been discussed for special hierarchical structures and free standing electrodes. The main research activities of Sakarya University electrochemical energy storage group has also summarized. The electrochemical performances of the ceramic based active materials and their nanocomposite structures were reviewed.

### References

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## **Ceramics and Lithium Ion Batteries: Solid Electrolytes**

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Electrolytes in Li-ion batteries provide the ionic conductivity between anode and cathode. Organic electrolytes are the most common electrolyte found in Li-ion battery market. They show satisfactorily high ionic conductivity but their easily flammable nature concerns to meet the regulations regarding safety. They also form a Solid-Electrolyte Interphase (SEI) which block chemical reactions and ion transportation between electrode material and electrolyte.

Solid-state electrolytes offer a new sight in the Li-ion battery field because of their enhanced safety. SEI could not be formed when solid electrolytes used. They consist of polymeric gels, inorganic solid compounds and inorganic glasses. Among them, inorganic solid electrolytes show relatively high ionic conductivity and relatively low electronic conductivity, a wide electrochemical stability window. The widely known examples of the inorganic solid electrolytes are Perovskite, Na-SuperIonic CONductor (NASICON), Lithium SuperIonic CONductors (LISICON) and Garnet type electrolytes. Perovskite structure of AB<sub>3</sub> general formula has excellent tolerance for ion substitution on both A and B sites resulting with large vacancy concentrations. Lithium conductivity depends on Lithium and vacancy concentrations. Even if NASICON and LISICON show good ionic conductivity; they are both highly unstable with Lithium metal. Garnet type electrolytes stand out with their excellent stability with Lithium, air and CO<sub>2</sub>. They also have high decomposition potential of 6V against Li along with considerably high ionic conductivity.

In this study, the state-of-the-art inorganic solid electrolytes that show Li<sup>+</sup> ion conductivity will be summarized and then, studies in our group and in Turkey on these types of electrolytes will be discussed.

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## Nanocomposite Ceramic Based Positive Electrodes for Li-ion Batteries

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Today, the importance of energy storage in telecommunication, automotive, energy and satellite technologies gradually increased. Lithium ion technology are lately extensively employed energy storage device for electric vehicles and all portable electronics. High gravimetric energy densities (up to 150 Wh/kg), cost friendly and enhanced safety with performance make Li-ion batteries suitable candidates for these applications. However, development of new cathode electrodes with higher energy densities with improved stability is still needed for enhanced devices. An intercalation cathode is a solid host network, which can store guest ions. The guest ions can be inserted into and be removed from the host network reversibly. In a Li-ion battery,  $\text{Li}^+$  is the guest ion and the host network compounds are metal chalcogenides, transition metal oxides, and polyanion compounds. These intercalation compounds can be divided into several crystal structures, such as layered, spinel, olivine, and tavorite.

This review covers key technological developments and scientific challenges for a broad range of Li-ion battery electrodes. Periodic table and potential/capacity plots are used to compare many families of suitable materials. Performance characteristics, current limitations, and recent breakthroughs in the development of commercial intercalation materials such as lithium cobalt oxide (LCO), lithium nickel cobalt manganese oxide (NCM), lithium nickel cobalt aluminum oxide (NCA) and lithium iron phosphate (LFP). New polyanion cathode materials are also discussed. The cost, abundance, safety, Li and electron transport, volumetric expansion, material dissolution, and surface reactions for each type of electrode materials are described. Both general and specific strategies to overcome the current challenges as in the form of composites are covered and categorized.

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## Ceramics and Sodium Ion Batteries

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Lithium-ion batteries have been extensively used as power sources for portable electronics and electric vehicles due to the high energy density and long cycle life. The large-scale applications of lithium ion batteries in portable electronics and electric vehicles will increase the price of Li resources due to its low abundance in the Earth's crust and its non-uniform geographic distribution. The increasing price of Li resources will result in the application of lithium ion batteries in stationary energy storage uneconomical in the near future. Therefore, the development of low cost, highly-safe and cycling stable rechargeable batteries based on abundant resources is becoming important and highly desirable. Sodium ion batteries have attracted great interest in portable electronics, electric vehicles and grid energy storage because of the cheap and abundant of sodium resources and using low cost Al current collectors for both cathode and anode electrodes.

The major challenge for sodium ion batteries is to find suitable electrode materials with excellent sodium storage performance. Transition-metal layered oxides, polyanion compounds and other compounds are used as cathode materials for sodium ion batteries while carbonaceous materials and oxides are used as anode materials.

In this presentation, cathode and anode materials for sodium ion batteries are reviewed, focusing on the latest research progress. Advantages and disadvantages of the currently available electrode materials will be discussed based on our experience and the literature.

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## **How to satisfy the EU demand for a slip resistance test that enables long term safety**

Richard Bowman

Intertile Research, Melbourne, Australia

European Directive 89/106/EEC required construction products remain safe during their entire life cycle. EU Regulation 305/2011 requires floors remain slip resistant throughout economically reasonable life cycles. The CEN/TC 339 slip resistance standards committee was obliged to establish a single slip resistance test method. The European Commission has funded the SlipSTD, Ultragrip and Slipsafe slip resistance research projects.

The SlipSTD project found the German ramp tests were generally applicable except on smooth surfaces (at the slippery end of the spectrum). The BOT 3000 and GMG 200 tribometers overestimated the wet slip resistance of very smooth floors due to slip-stick effects, while measurements on structured and textured surfaces were impaired by loss of contact. The pendulum was well suited to smooth, structured and textured surfaces. Measurements on profiled surfaces were considered to be impaired by impact variations, but specimen orientation can overcome this issue. The pendulum has the widest operating range. It also only requires a small test area.

The Ultragrip project used an industrial tile polishing machine to provide a sufficiently large worn area for slip resistance testing: there was good correlation between the slip resistance of accelerated conditioned tiles and those that wore in service. The Slipsafe project used a washability tester for accelerated conditioning and the pendulum for slip resistance testing of resilient flooring.

In Australia, accelerated conditioning is routinely used to assure long-term slip resistance. Satisfying the EU sustainable slip resistance mandate requires testing products after appropriate accelerated conditioning. When will CEN/TC 339 take the lead?

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## Efficient Use of Nepheline Syenite as a Fluxing Agent in Industrial Ceramic Formulations

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Feldspar and clay minerals are employed in ceramics industry as a raw material. Apart from these, feldspathoid (especially nepheline syenite) group minerals are commonly preferred in formulations. Nepheline syenite is a quartz-free aluminum silicate complex rock consisting of different mineral phases such as nepheline, alkali feldspar, and biotite. Because of its extremely low melting point and high alumina content, nepheline syenite is used as a glass phase promoter, a ceramic flux and also as a functional filler in paint, plastics etc. Like Feldspar, nepheline syenite is used as a flux in tile, sanitaryware, porcelain, vitreous and semi-vitreous bodies. It contributes high alumina without associated free silica in its raw form and fluxes to form silicates with free silica in bodies. This stabilizes the expansion curve of the fired body. It is an excellent filler and flux, especially for fast firing conditions. Nepheline syenite is valuable in glass batches to achieve the lowest melting temperature while acting as a source of Alumina. Kırşehir Buzlukdağ nepheline syenite represents one of the largest and unaltered alkaline intrusive body in Central Anatolia region of Turkey. Main mineral composition is nepheline (15-35 wt. %), K-feldspar (orthoclase) (41-69 wt. %), albite (25-37w. %), biotite (0.3-2.5 wt. %). Buzlukdağ nepheline syenites have K<sub>2</sub>O/Na<sub>2</sub>O and Na<sub>2</sub>O/K<sub>2</sub>O ratios between 0.44-1.5 wt. % (mean 0.60 wt. %) and 0.89-2.66 wt. % (1.53 wt. % on average) respectively, thus they are very suitable for ceramic and glass industries.

In this study, Usability of Buzlukdağ nepheline syenite was examined as fluxing in place of albite in ceramic tile and ceramic sanitaryware bodies. The rheological behavior, energy efficiency and its effect on technical properties of the representative bodies were examined.

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## **Optimization of Firing Processes of Ceramics using Thermal Analysis Methods and Kinetic Modelling**

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In the production of ceramics, a green body is frequently manufactured of ceramic powder and additives (binder, sintering aids). This material is then shaped into a green body. The green body is converted into the final product through thermal treatment at high temperatures. The temperature program during the firing process, especially during the binder burnout and in the sintering phase, has a lasting effect on the subsequent characteristics of the product. Optimization of the temperature program during firing and to shorten the duration in the kiln will increase productivity and reduce production costs. Thermophysical properties like density change, specific heat and heat transfer have to be known. Pushrod dilatometers have been used for decades to investigate length changes of ceramics during sintering. Thermogravimetric measurements can be used to analyze the binder burnout and decomposition reactions. Differential Scanning Calorimetry (DSC) can be used to measure the specific heat and enthalpy changes. Laser flash method is well-established for determination of the thermal diffusivity. By combining the results of all measurement methods, it is possible to determine the thermal conductivity of the material and to predict the temperature gradients in ceramic parts by employing finite element simulations. Measurements on Zirconia with the different methods will be shown as example.

Using measurement results achieved at different heating rates and an applying advanced thermokinetic analysis software (NETZSCH KineticsNeo), one can analyze the kinetics of the binder burnout and sintering processes. Understanding the reaction processes allow modelling of the temperature profile for various scenarios. Examples will be presented showing optimized temperature programs shortening the firing time.

## **EVOLUTION OF SPANISH TILE MANUFACTURING INDUSTRY. SUSTAINABILITY MARKS THE FUTURE**

**Vicente Sanz**

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The manufacture of ceramic tiles in Spain has a long tradition. Spain is one of the main world producers, with a product of excellent quality endorsed by the great penetration in a large number of world markets. It is a sector in constant technological evolution that has led to the transformation of a productive process derived from the purest artisanal tradition, to a highly technified process in line with the digital era.

However, the production of ceramic tiles still presents important challenges derived, fundamentally, from the need to harmonize their evolution with an increasingly sustainable development. The large consumption of material resources (raw materials and water), energy, as well as greenhouse gas emissions are the great future challenges of this industry.

This paper describes, in a first part, the main milestones of the Spanish ceramic tile industry in the last 40 years, including the role that the Institute of Ceramic Technology of the Universitat Jaume I of Castellón has developed during all these years.

Based on this evolution, the ongoing and future developments necessary to achieve an increasingly sustainable industry are described. The full development of water-based digital decoration, the use of energy and its exploitation for water recovery, the reduction of the carbon footprint and the incorporation of renewable energies in an efficient way in the process are some of the aspects that, without any doubt, will be part of this sector in the near future.



Topic: “***Current Battery Technology and Electrical Vehicles***”

Muhsin MAZMAN

**Cont**

- **Battery market forecast**
- **Battery Technologies and the challenges**
- **New requirements and studies on batteries**
- **Beyond li-ion**

Volkan KARAHAN  
Yiğit Akü, Turkey

Industrial Production of Lithium Ion Batteries in Turkey

**DIGITAL "KNOW-HOW"****Giorgia Ferrari**

Smaltochimca SpA offers to its customers a wide range of possibilities in the digital ceramic world. These opportunities include finished digital products (inks, effects, and glues), mediums for milling directly in customers' plants and the whole milling and quality control system.

Regarding digital products, Smaltochimica portfolio includes:

- Inks: "NIK" series
- Effects: "SDM" series
- Glues: "DIGICOL" series

In the last 2 years, Smaltochimica has gained a high expertise in digital glues formulation, production and application. Digital glues have born as an answer to the fast and deep technological digital revolution of the last few years, substituting the traditional sbobba thanks to many pros, in terms of application and yield.

Smaltochimica has developed different classes of DIGICOL, from total liquid glues to product containing an inorganic phase, to respond to a highly demanding market.

In parallel, customers can build their own milling plant and become independent, with the constant support from Smaltochimica, which includes installation and continuing assistance. Production plants consist of mills, storage tanks, automatic or manual filtering and bottling system, lab supplies for quality control.

Smaltochimica can also offer different proposals of milling and dilution mediums, which allow our customers to create their own system of production, depending on their necessities. Among this portfolio, MCF series is surely the most versatile.

Last but not least, our specialized department, Colour Service, is able to support costumers in the colour management world, with specific software (Colour Profiler) and instruments (spectral scanners).

## **SLABS PRODUCTION AND FULL DIGITAL DECORATION CONTINUA+ AND TRADITIONAL PRESSING**

### **NEW PLANT PROPOSALS**

*Benedetto Spinelli*

In order to compete in the global market of ceramic tiles it is necessary to propose a wide range of products and different size and decoration possibilities.

In parallel it is also important to limit production costs.

Each new logic of production must foresee a high flexibility and to this purpose Sacmi proposes plant solutions based on the new available technologies.

One is surely represented by Digital Decoration, which allows easy realisation of a great number of products having excellent aesthetical quality with competitive costs.

A second opportunity is represented by plants for Large Sizes, which considerably simplify the production flow and allow to produce a great variety of modular sub-sizes.

#### **Digital Decoration**

The Digital Decoration has already widely established thanks to its unquestionable advantages, which hugely overcome the initial problems.

High graphic resolution, easy realization of prototypes and product changes, decoration without contact even on structured surfaces, little production lots, ...., limited production costs.

So far the introduction of Digital Decoration occurred with two main aims:

- simplify the decoration lines and realise products of good quality with a lower number of applications
- implement the digital machines on the existing lines, by integrating traditional applications

On the contrary, the real revolution in glazing will be possible thanks to the introduction of full digital decoration, with effective reduction of lines length, greater automation, opportunity of connecting the effects deriving from both dry and wet decoration and easier running.

Therefore, the digital decoration aims at the application of traditional glazes and engobes but above all at the realisation of ceramic surfaces having new chromatic/optical (glossy/matt, iridescent effects, ...) and tridimensional (relief structure) effects.

#### **Lines for Large Sizes**

Sacmi plant proposal, with the aim of achieving the highest production flexibility, is represented by recent introduction of lines for large size porcelain slabs.

The advantages of a plant for large sizes are: easy running, higher quality of achievable products, possibility of producing modular sub-sizes by cutting without any die change, reduction of the number of stored finished products.

The most typical large size is 1200x1200 without doubt, which is multiple of standard 600 and 300-sizes.

The size 900x1800 is also interesting for exploiting the space between press columns.

Anyhow the large size par excellence is 3000x1500, with several combinations of interesting submultiples.

On the contrary, the production of only one size at kiln outlet hugely reduces warehouse cost (an intermediate warehouse is enough) but then the cutting costs are higher.

Sacmi proposals for the production of large sizes are:

- traditional line with PH10000 and fast die change, in case
- Continua+

#### Traditional line with PH10000 and fast die change

It allows the realisation of 1200x1800-max. size and any thickness (3÷30 mm) with output up to 10.000 m<sup>2</sup>/day.

#### Continua+

It is the NEWEST compacting technology by roller from Sacmi, which allows to produce very large sizes (up to 1600x"unlimited"). It is suitable for thickness ranging from 3 to 20 mm, in function of which it is possible to achieve very high output (12.000 m<sup>2</sup>/day).

In particular, the new Continua+ technology shows a simple, linear and automated working flow and perfectly integrating with Digital Decoration technologies, such as Dry Digital Decoration, Digital Glazing and Inkjet Decoration.

As a consequence, Sacmi believes the production lines for Large Sizes integrated with digital technologies represent a valid solution for the development requests of the ceramic market because it deals with highly flexible solutions, able to realise products with high added value and with limited costs.

## INKJET INKS FOR CERAMIC

### Carlos David Diez

Many customers tell us: *"I'm using ceramic inkjet inks but I'm only know that is a coloured liquid"*

The main issue in this conference is to give a simple tour around an inkjet ink and a ceramic inkjet ink:

- What's an inkjet ink?
- What's a colouring matter?
- What's a medium?
- How to make a ceramic inkjet ink?
- What parameters do we need to control?
- What we need to avoid in any ceramic inkjet ink?
- What kind of inkjet inks MEGACOLOR offers?

Marco CAVOLI  
Bluenco

Ink Filterability: A Different Approach for Ink Quality Control

**COLOROBBLIA: ON THE VERGE OF SOMETHING BIG.**

Miguel Angel JOVANI

Colorobbia

Colorobbia has focused on the latest technological innovations to offer, to the worldwide producers of large format tiles, a top level of expertise not only in Manufacturing, Engineering and Design but also in novel application techniques.

Innovation means that Colorobbia's wide portfolio of product series, comprising frits, pigments, compounds, hardened spray dried glazes, digital inks, granular frits, protections etc... provides an infinite number of combinations to obtain enhanced performance and aesthetics and thus high added value large format tiles. Actually, Colorobbia series of special frits for porcelain body have become a market standard for top quality porcelain tiles.

Another clear example of technological progress is that the production lines of large and extra large formats have become more simple thanks to extensive industrial experience with the use of spray-dried glazes in the pre-press stage, and consequently less energy consuming. Going several steps further, Colorobbia has developed the AIR (Air-friendly Inks Range) concept to minimise the levels of both atmospheric emissions and unpleasant smell at the exit of kiln chimneys, which occur due to incomplete combustion of organics when high laydowns of oil based inkjet inks are applied. Today, the AIR concept, which is based on a Full Digital process, is the best rated environmental solution in the Ceramics market.

Finally, Colorobbia has been fully committed to the development of the Industry 4.0 Evolution, having several open collaboration projects with the leading producers of large format lines to analyse and evaluate different continuous monitoring systems.

As always, Colorobbia develops and studies continuously all the products from the source, paying maximum attention to environmental and safety aspects which are related with the manufacturing processes, a strong policy and commitment established since the day that the company was born almost one hundred years ago. The proof is our strong knowledge of international regulations and requirements from the markets and local authorities but also from our customers, because our highest commitment with them is to be a trustful partner.



## Durst True Digital Industrial Ceramic Tile Manufacturing 4.0

Christian HARDER  
Durst Phototechnik, Italy

**Abstract**

As Turkey's only integrated aluminum plant capable of aluminum from ore as well as handling production from mining to final product, Eti Alüminyum A.Ş. (ETİ) contributes significantly to the regional and national economy. ETİ, the only primary aluminum producer in Turkey, was taken over by Cengiz Holding in 2005 within the scope of privatization. The plant is still being renovated and has been almost rebuilt from scratch with an investment of USD 580 million since privatization. After almost facing closure during the privatization period, ETİ today provides 10% of Turkey's aluminum at its Konya Seydişehir facilities.

While the renovation work increased energy efficiency by 15%, new technologies commissioned in mid-2015 increased the production capacity of ETİ to 82,000 tons. Annually, the plant can treat 550,000 mt of bauxite ore and produce 160.000 mt of cast products as well as 260,000 mt of aluminum oxide (alumina) using 400,000 mt of aluminum hydroxide produced at the plant. Besides, energy efficient, human and environment friendly technologies, ETİ gives priority to research and development studies as well. Adopting the manufacture of value added advanced products which are completely exported as a principle, ETİ has developed several grades of aluminum hydroxide and alumina products for mainly ceramics, refractory, semi-conductors, high voltage insulators, glass, glaze and frits, polishing and abrasives, plastics, composites, adhesives, artificial marbles. In this paper, alteration of production and management milestones and achieved product portfolio are introduced.

**Recent Studies on Refractory Materials and New Markets in Magnesia Products**

Dr. Özkan KURUKAVAK,

KÜMAŞ Manyezit Sanayi A.Ş., Kütahya/Turkey

KÜMAŞ produces and supplies sintered magnesia, fused magnesia, fused oxychrom and calcined magnesia. These products are derived from high quality microcrystalline natural magnesite ore for supply into the industrial minerals market. In addition KÜMAŞ produces basic refractory materials such as magnesia, dolomite and alumina based refractory brick and mortars in its integrated refractory plant. KÜMAŞ has raw material mines, thereby gaining advantage of continuity in production, consistently high quality products and cost control which is reflected in the commerciality to its customers. From raw materials to refractory products and up to complex refractory concepts – our successful basic research is based on in-depth knowledge of the relevant process technologies of the user industries especially iron-steel, cement, lime, glass and non-ferrous metal industry. In recent times, KÜMAŞ is focused on projects related with magnesium chemicals to produce value added products from its own magnesite raw material. Magnesium chemicals are used in waste water treatment, hydrometallurgy, fertilizer, heating elements, animal nutrition, flame retardant and construction panel industry.

## **From Lab to Market:**

### **Story of a New Generation Particle Technology: MicNo®**

#### **Ender Suvacı**

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Nanomaterials play critical roles in today's world. Among them, nanoparticles are the most widely utilized group and they have been successfully utilized in many technological applications from electronics to medical industry. Fine size of nanoparticles (typically <100 nm) brings unique properties that can not be achieved at larger sizes (i.e., in submicron or micron form). Although nanoparticles possess unique properties, their fine size may cause processing difficulties such as uncontrolled agglomeration, health and environmental problems. Consequently, when scientists deal with nanoparticles, they should not only focus on advantages of them and produce more and more of those particles but also be aware of the potential problems associated with such fine particles and develop new solutions to overcome such potential problems while maintaining unique properties of nanoparticles. Accordingly, our research group with the sponsorship of Entekno Materials, Ltd. ([www.enteknomaterials.com](http://www.enteknomaterials.com)) developed innovative MicNo® Particle Technology, provides both safe and environmentally benign nanoparticle solutions. MicNo particles are designed, platelet shaped micron particles which are composed of nano primary particles. In this presentation, application of the MicNo particle technology to ZnO system and subsequently both optical and biological properties of MicNo®-ZnO particles will be discussed in detail. In addition, transition of MicNo®-ZnO particles to commercial applications will be presented.

**Doç. Dr. Yüksel PALACI**

## **Seramik Prototip Üretim Metotları**

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### **ÖZET**

Prototip üretimi seri üretime geçmeden önce, ARGE amaçlı sınırlı üretim ve yedek parça üretimi için önemli rol oynamaktadır. Seri üretime geçmek zaman ve maliyet gerektirmektedir. Ürünlerin, seri üretim öncesi performanslarını ölçmek ve bir bütün olarak, diğer ürünlerle etkileşimini inceleme fırsatı sunmaktadır. Ayrıca seri üretim öncesi müşteri onayı ve gerekli kalite belgeleri ve sertifikaların alınması aşamasında zaman kazanılmasını da sağlamaktadır.

Seramik prototipleri de, çeşitli metotlarla üretmek mümkündür. Bu metotları, plastik şekillendirme, eklemeli üretim ve eksiltmeli üretim olarak sıralayabiliriz. Plastik şekillendirme metotları olarak, Düşük basınç enjeksiyon kalıplama, ekstrüzyon, presleme, şerit döküm, asıntı döküm, ve benzeri verilebilir. Eklemeli üretimlerde, eritme/katılaştırma, ışık ile sertleştirme, yapıştırma, lazer sinterleme, ve eritme biriktirme olarak sıralayabiliriz. Eksiltmeli üretimi de, lazer veya iyon demeti buharlaştırma, yaş işleme, beyaz işleme ve sinter sonrası işleme olarak sıralayabiliriz.

Bu sunumda, farklı metotlarla üretilmiş prototiplerden örnekler verilecek ve metotların ürün özelliklerine, üretim süresine ve maliyete etkileri tartışılacaktır.

Anahtar kelimeler: Seramik, prototip, üretim

**Assoc.Prof. Dr. Yüksel PALACI**

## **Ceramic Prototype Manufacturing Methods**

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### **ABSTRACT**

Prototype production plays an important role for limited production, spare parts production and for R&D before serial production. Passing serial production requires time and cost. Prototype production offers the opportunity to measure products' pre-production performance and, as a whole, to explore interaction with other products. It also provides pre-production customer approval and time-saving of obtaining required quality documents and certificates.

Ceramic prototypes can be produced by various methods. We can list these methods as plastic forming, additive manufacturing, and subtraction manufacturing methods. Examples of plastic forming methods are low pressure injection molding, extrusion, pressing, type casting, extrusion, slip casting, and etc. In additive manufacturing, we can list as melting/freezing, UV light hardening, glue bonding, Selective laser sintering, and melting accumulation like ion beam

melting. We can rank subtractive production as, laser or ion beam evaporation, green machining, white machining, and machining after sintering.

In this presentation, examples of prototypes produced with different methods will be given. Prototype ceramic part characteristics depending on the manufacturing methods, production time, and financial effects will be discussed.

Keywords: Ceramic, Prototypes, Manufacturing

## Ceramics and Energy: Contribution of Ceramic Materials to the Performance and Processing of Supercapacitors

Mustafa ÜRGEN

Istanbul Technical University, Turkey

## Massimo PRODI

### PRIME

The demand for product personalization and the reduction of lots, the complete digitalization of processes, the use of shared resources and the efficient management of data, are new challenges with modern manufacturing industries. These are fundamental elements for the sustainable development of the new paradigm based on:

- Intercommunicating Technologies “Industrial Internet of Things”;
- Perimeter of action “from Customer to sensor”
- Improvement of the concept of “Lean Manufacturing”
- Implementation of “Make to Order”;

PRIME is the answer of System: a software services platform developed internally, interface natural 3D real time, integrated with Enterprise Resource Planning (ERP), direct connected with machines, designed to be predictive, incorporates analysis tools, covers the 5 levels of stack ISA 95.

The system, highly integrated and connected, makes it possible to organize the information flows of entire plants, and is designed to meet the following requirements:

- control entire plants and more factories;
- standardize data management;
- provide simple information to guide decisions;
- reduce product change times;
- optimize production lot;
- obtain the actual production cost;
- move towards the «zero defects» target;



## Ximo PIQUER

NEOSAWARE proposes modeling, simulation and mathematical optimization as an alternative to trial-error procedure. NEOSAWARE computer engineering combines a self-awareness concept with the ceramic know-how, suitable to find solutions in complex and heterogeneous systems in our industry.

This artificial intelligence technology provides quick by evaluating millions of formulas to achieve maximum cost reduction and increased quality

Enrico QUARTIERI

## LAMGEA TECHNOLOGY FOR PRODUCTION OF BIG TILES & SLAB

This is a presentation of System's technology Lamgea for the production of ceramic big tiles and slab surfaces. System Spa introduces this technology in the market 13 years ago, and specially in the last 3 years we made relevant numbers of installations and this technology is spreading well all over the world.

Thanks to Lamgea technology is possible to produce big size ceramic slabs, in variable thickness from 3 to 30 mm, and with dimension up to maximum size 1600x4800 mm, with very high production capacity.

After the press, the slab can be handled and produced in its big entire dimension, or green cut in subsizes, according to the necessity of the customer and the final destination of use, allowing the customer to be free to decide whatever thickness he needs to produce irrelevant by the size

The main technical characteristics and advantages of the ceramic product realized with our technology are:

- No residual tension inside the body after the press
- Limited caliber variation at kiln exit: +/- 2 mm (optimization in rectifying process)
- Great planarity of the product (optimization in polishing/full lappato process)
- Possibility of structured relief surfaces, with structures up to 2 mm depth, in high resolution
- Possibility of production big size in lower thickness, with great saving of raw material, great saving of energy (electrical and gas), transport cost (lighter material)

Moreover, here below the main advantages and plus point of our Lamgea technology:

- Press functionality easy to learn
- Simple process to manage and very stable over the time
- Use of standard body: no additive nor specific composition
- Standard body humidity 4 – 6%
- No foundations requested
- 100% wastage recovery
- Reduction of greenhouse emissions

The products realized with our technology can have several different destination of use, such as wall and floor application, outside façade, countertop for bathrooms and kitchens, interior furnishing and complements

## Gökçe DARA

### *Ceramics and Armours: the state of the art in ceramic armours and future potentials in Turkey*

#### *Abstract*

Ceramics with their intrinsic properties became material of choice for ballistic protection against armor piercing rounds in body armour and aircraft platforms. With increasing asymmetric warfare situation armies increasingly looking for better armor protection, thus survivability and ballistic protection became the main factor for land vehicle designers. The lighter and higher protection capability composite armors increasingly relied on ballistic ceramics and polymeric composites for protection against light to medium caliber direct fire threats and improvised explosive device (IED) threats in the last 20 years. With the wide spread use of anti-armor shape charge threats ballistic ceramics found a new application field in passive armors providing better performance in some aspects accordingly becoming an alternative to reactive armor for armored vehicles. Turkey with significant number of armored vehicle manufacturers has great requirement and potential for armor development and production.  $Al_2O_3$ , SiC and  $B_4C$  constitutes the bulk of the ballistic ceramic market with significant research going into reducing price and increasing performance of these materials. On the other hand so called nano-ceramics and novel ceramic composites and 3D printing techniques allowing bio-mimicking structures combining two or more materials requires special attention for future armor applications. In this review a brief summary of ballistic ceramic evolution will be given followed by current market shares and future trends will be explored.

**Processing and Performance of  $\alpha/\beta$ -SiAlON Ceramics**

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SiAlONs are ceramic materials with a range of technically important applications, from cutting tools to wear parts and the properties of SiAlONs can be tailored for specific applications.  $\alpha/\beta$ -SiAlONs have been widely used for machining of cast irons and superalloys where the performance of the material is governed by intergranular phase chemistry. With this respect, types and amount of liquid phase sintering additives, which affect the distribution and crystallinity of intergranular phase and remnant of the additives after sintering, play an important role. This presentation will address the effect of various types of sintering additives on the intergranular phase chemistry and microstructures of  $\alpha/\beta$ -SiAlONs and their subsequent performance in cast iron turning and in high speed superalloy milling. Some processing issues related to SiAlON ceramics including pressureless sinterability as well as shaping of complex parts by coagulation casting will also be mentioned.

Sedat ALKOY  
Gebze Technical University

Piezoelectric Ceramic Fibers and Fiber-based  
Piezocomposites

## Emerging Applications of Halloysite-Polymer Nanocomposites

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Halloysite is a clay material with hollow nanotube structure. As a naturally occurring nanotube with aluminosilicate chemistry, nano-sized radius, high length-to-diameter ratio and contrast chemical properties between inner and outer lumina, Halloysite Nanotubes (HNTs) have been intriguing templates to immobilize nanoparticles. In addition, HNTs are very convenient materials for nanocomposite applications due to their cost-efficient mass-production. Therefore, these natural nanotubes have been promising materials in many research fields, particularly in industrial research applications.

A remarkable application of HNTs is the loading of inner lumene with various active agents, including macromolecules, followed by extended/delayed release of the active agent. Incorporating with industrial polymers, this method offers a wide variety of substantial applications ranging from chemical carriers to controlled release agents. Preparation and applications of nanocomposite films, in which the active agent-filled HNTs are incorporated into polyolefin matrices, will be discussed in two case studies. The applications of such films in the area of active food packaging and controlled release of pesticides will be explained in detail. Process details along with mechanical and thermal traits of nanocomposite films will be explained. Activity tests of the nanocomposites and the observed advances with respect to application area will be presented.

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## High Temperature Processing and Sintering

### Powder Syntheses of Advanced Ceramics Using Novel Approach – DCR Process

#### *İleri Teknoloji Seramik Toz Üretimi İçin Yeni Bir Yaklaşım - DKTİ Prosesi*

Ali Osman KURT

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Advanced ceramics are critical material in many industries, such as health, electronics, military, high temperature and many other area of applications. They are in general costly products due to the nature of their production methods that initially rely on high quality synthetic powders. Good quality powders, i.e., high purity, very fine and uniax grains are very expensive and could be obtained with complicated and costly processes. Therefore, it is important developing new and competitive powder production techniques to enabling easy access to cheap ceramic powder raw material supply. In this concept, recently the dynamic / carbothermal reduction (DCR) process was developed and successfully applied in synthesizing some advanced ceramics powder, namely silicon nitride (both  $\alpha$  or  $\beta$  form of  $\text{Si}_3\text{N}_4$ ), aluminium nitride (AlN), boron nitride (BN), boron carbide ( $\text{B}_4\text{C}$ ), titanium nitride (TiN), zirconium nitride (ZrN) and titanium diboride ( $\text{TiB}_2$ ). DCR is the high temperature process taken place between 1300 – 1500 °C under controlled atmosphere in rotary furnace. Although DCR technique was successful in synthesizing such important advanced ceramic powders in required quality, it was only applied in laboratory scale (i.e. on the order of a few grams per day). Further work for prototype scale (a few kilograms per day) synthesis of such powders are planned before moving to the industrial scale (a few hundred or tons per day) production.

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## Low temperature synthesis and characterization of high purity nano boron carbide (B<sub>4</sub>C) structures

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### Abstract

Boron carbide (B<sub>4</sub>C) is accepted as an important engineering material due to its high melting point, high hardness, high Young's modulus, excellent radiation (neutron) absorption properties and low thermal conductivity. Although different methods, such as high temperature carbothermic reduction and chemical vapor decomposition, have been used to synthesize boron carbide, a low cost technique that provides high purity B<sub>4</sub>C with no residual carbon, is required by industry. Therefore, in the present study, synthesis of high purity, high crystallinity nanostructured boron carbide particles with various morphologies, is proposed using a modified low-temperature sol gel process. The effects of starting chemicals, calcination and sintering temperature/time on the formation of B<sub>4</sub>C structures, morphology and stoichiometry were reported. Detail characterization studies including TEM, XRD, NMR and DTA were used to support the results on the formation of stoichiometric boron carbide with high crystallinity at low temperatures.

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## **Synthesis of Environmentally Friendly (h00) Oriented Plate-like Lead Free Ceramic Powders for High Performance Piezoelectric Ceramic Development**

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It is estimated that global market for piezoelectric actuators alone to be approximately \$ 7 billion with a steady 13% growth rate annually. Most of the products in the market have > 60 wt.% lead oxide within their compositions which is very toxic for environment and human health. With the increase of environmental awareness, most developed countries have regulations which restrict the use of toxic materials and encourage the development of lead-free materials for electronic applications. There are two approaches to develop lead-free ceramics with high and applicable performances: (i)- designing chemical composition and (ii)- texturing microstructure with desired crystallographic direction. Very high piezoelectric responses and strains can be obtained by texturing. (h00) oriented anisometric particles (templates) are basic components for textured ceramics. In recent technology some transition temperature variations could be occurred in textured ceramics produced via Templated Grain Growth (TGG) or Reactive TGG methods. It is postulated that lattice mismatch between the templates and oriented grains could cause interfacial stress and polar nanoregions and thus the phase transition temperature variations. According to synthesis techniques, templates could have some impurities which affect crystal structure beside chemical composition. The findings in this work facilitates to design chemical and physical properties of templates for textured lead free piezoelectric ceramics with high temperature stability and piezoelectric performance. In this presentation, effects of processing conditions on particle chemistry, size and shape during plate-like particle synthesis will be discussed in detail.

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## Recent new applications of hBN

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Boron nitride (BN) is a synthetic material, and they synthesized in different crystalline structures such as hexagonal, cubic. Based on their crystalline structures, they show different physical and chemical properties. Balmain first synthesized BN in 1842; it took until the 1940s before it gained limited economic significance. Looking at past industrial trends, it was not used till 1990s because of the high production cost. Hexagonal boron nitride (hBN) is used in various industries than the other polymorphs. Depending on its structural characteristics, hBN is a good solid lubricant, chemically inert and a very good electrical insulator with high thermal conductivity and good thermal shock resistance. This very versatile material has been utilized in a number of applications (metallization, the metal industry, space industry, cosmetics, the automotive industry, high-temperature furnaces, thermal management, etc.). Recently, hBN nanomaterials (nanoparticles, nanotubes, nanosheets etc.) has attracted attention due to its unique properties in nuclear technology, marine antifouling paint, biological and medical applications, biomarkers and biosensors technologies, and drug delivery systems, implant coating, oral care products as they have no toxic and cytotoxic effect on cells and are biocompatible.

## Recent developments in the field of epitaxial ferroelectrics

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Ferroelectrics are multifunctional materials with a broad range of applications, many of them based on two very important material quantities: the spontaneous polarization and dielectric constant. Here we discuss a few aspects regarding the two quantities, namely:

- Complex relation between electrode interfaces, polarization and leakage current, based on experimental results showing that the properties of the electrode interface (especially the magnitude of the barrier height) are largely controlled by the spontaneous polarization. Examples will be given for several materials including two PZT compositions, BaTiO<sub>3</sub> and BiFeO<sub>3</sub>.
- Possible self-doping effects in epitaxial ferroelectric films, suggested by the results obtained on PZT layers grown on SrRuO<sub>3</sub> electrodes. The microscopic analysis underlines that vacancies are involved, being generated during the growth of the films with dominantly upward polarization. The results also suggest that compensation mechanisms are different in very thin films and bulk.
- Uncertainty on the values of material constants, especially dielectric constant, as the reported numbers spread over order(s) of magnitude. Examples are given, in relation to microstructure, interfaces and measurement conditions. All the results strongly suggest that extremely high precautions should be taken when selecting experimental values for simulations or theoretical modeling. A few comments are made on this problem of “material constants”.

At the end, some new developments towards applications in high-tech domains will be presented (e.g. non-volatile memories, pyroelectric IR detectors).

## SHAPEABLE MAGNETOELECTRONICS AND MAGNETORESISTIVE BIOSENSORS

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Shapeable (flexible, printable, and even stretchable) magnetoelectronics became one of the most important technological research fields of the last years. Foreseeable applications of highly sensitive, cost effective and re-shapeable magnetoelectronics also include magnetic particle detection in microfluidics and lab-on-a-chip platforms. Magnetoresistive-based biochips, detect magnetic labels instead of fluorescent labels, have been extensively investigated for sensitive measurement of low bio-target concentration in body fluids. The main aim of these investigations is development of high sensitive magnetic field sensors that are optimized for magnetic label detection. All magnetic biosensors detect the stray field of magnetic particles that are bound to biological molecules. Since the biological environment is normally non-magnetic, the possibility of false signals being detected is negligible. In this talk, I will give a brief information about shapeable magnetoelectronics and explain the principles of magnetoresistive biosensors. I will also talk about our ongoing research on planar Hall effect-based biosensor applications.

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## DISPLAY TECHNOLOGIES AND THIN FILM DEPOSITION TECHNIQUES

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OLED is a new technology, which can be applied for Displays and Lightings. OLEDs have many advantages over the alternative technologies: They are thinner, lighter and more flexible. OLED devices require low voltage and low power. Since OLEDs can be flexible, they have robust design facilities in terms of geometry, size etc. In a typical OLED device: there are substrate, anode, hole transport layer (HTL), emissive layer (EML), electron transport layer (ETL), and cathode. OLED substrates should have good H<sub>2</sub>O and O<sub>2</sub> barrier properties besides transparency. OLED active layer materials are generally two types: polymers and small molecules. Small molecules have limited solubility therefore they are processed by vacuum deposition methods to produce thin films. Polymers are soluble and can be processed by solution based methods spin coating, inkjet etc. Inkjet printing is used to deposit exact amount of material on an addressable places. Therefore one can print RGB materials in different pixels in very defined way. For this method almost there is no material waste. On the other hand small molecule fabrication requires high vacuum, shadow mask and mask aligning for RGB pixels. Material waste is very high, so it is expensive method.

## Smart Structures: Metal Oxide Nanoscale Materials

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The metal oxide materials (VO<sub>x</sub>, WO, V-WO, Y-Ba-Cu-O, TaO<sub>x</sub>, BaSrTiO<sub>3</sub> and La-Sr-Mn-O) compared with metallic and semiconductor resistor materials (Pt, Si-Ge, amorphous Si) became importance due to their high and widespread application potentials in optoelectronic devices and systems. Among these materials, vanadium oxide has gained great importance due to its superior electrical and optical properties. Several efforts were made to produce vanadium oxide (VO<sub>x</sub>) ceramics in nanoscale due to their outstanding physical and chemical properties applicable in many technologies such as smart windows, thermochromics, energy-harvesting, batteries, thermal cameras, night seeing, security issues etc. [1,2]. In form of nanoscale thin films, VO<sub>x</sub> ceramics indicates low electrical resistivity, adequate temperature coefficient of resistance (TCR), low electronic noise and capability to integrate into the CMOS devices, which make these thin films essential for uncooled IR-detectors, i.e. microbolometers [3]. Between different phases (VO, V<sub>2</sub>O<sub>3</sub>, VO<sub>2</sub>, V<sub>6</sub>O<sub>13</sub>, V<sub>3</sub>O<sub>7</sub> and V<sub>2</sub>O<sub>5</sub>), V<sub>2</sub>O<sub>5</sub> phase indicate high TCR, but high electronic noise [3-5]. VO<sub>2</sub> is desired due to its extended optical properties [6,7], adequate TCR and low electronic noise; however, high deposition or post-annealing temperatures (>400°C) are crucial in production of the films with VO<sub>2</sub> phase. Recent works reveal that the post-annealing processes open more possibilities to optimize properties of vanadium oxide thin films for detector applications [8,9]. However, the post-annealing conditions must be applicable to the CMOS production, especially annealing temperatures (<400°C) are necessary to protect the CMOS structure [1]. The present work focuses on the influence of post-annealing process on the structural properties. The correlation between structural and electrical properties including electrical noise is going to be discussed.

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## Spintronics at nanoscale metal/ceramic interfaces

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Magnetic sensors using different effects based on the spin of electron are now being used in automobile and mobile systems as well as in DNA or protein detection [1, 2], under the name "spintronic devices (spintronics)". In parallel, the "Industry-4.0 revolution" – digitalization and intelligent systems – has further increased the potential of spintronic devices to be used in the "intelligent materials" category [3]. Design of the spintronic devices are based on Spin Hall (SHE) [4] and Tunnel Magneto Resistance effects (TMR) [5]. The disadvantages of spintronic devices using SHE and TMR effects can be listed as complex and costly production processes, the high energy consumption and necessity to use of an external magnetic field.

The recently developed spin Hall magnetoresistance (SMR) effect based on the SHE has drawn increasing interest. SHE effect is closely related to the spin-torque effect [6], which enables to design spintronic devices with low energy consumption and without an external magnetic field. In this context, different materials have been studied: YIG,  $\text{CoFe}_2\text{O}_4$ ,  $\text{NiFe}_2\text{O}_4$ ,  $\text{Fe}_3\text{O}_4$ ,  $\text{LaCoO}_3$ ,  $\text{CeFeB}$ , Pt, Pd [7, 8, 9]. Based on current research results, it is stated that the ratio of SMR effect at the extruded metal/ceramic interfaces such as W/ $\text{CoFeB}$ / $\text{MgO}$ /Pt can be increased up to 70%, based on the comparison between nanoscale metal/ceramic binary and triple thin film systems [6]. Material systems with higher SMR effects can be more easily utilized in spintronic devices with lower production cost and low energy consumption [7, 8].

In the present work, the potential spintronic device structures and nanoscale metal/ceramic material systems are going to be discussed.

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## “Ceramics and Energy: Intermediate temperature solid oxide fuel cells”

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Recent developments in renewable energy is likely to transform the current energy system into a new form. Solar and wind energy with a cost less than those produced by fossil fuels would be the dominant mode of energy production. Intermittent nature of these energy pose a number of problems that need to be solved in coming years. Intense research efforts are currently underway to develop low-cost batteries to be able to store these energies and release it when needed. The overall energy system involves not only electricity but also natural gas. These two grids need to be considered together in the coming era. To switch energy from one grid to the other is essential for the proper integration of these energy system. Currently it is possible to convert the energy of natural gas to electricity via thermal power plants. The reverse is also possible in theory, i.e. power to gas conversion, but currently there are a very few examples of it. This switch from conversion of power to gas is important not only for the proper integration of the energy system, but also because it is much easier to store gas than it is to store electricity.

Fuel cells as a energy conversion devices have been in the center of much research efforts over a number of decades. Solid oxide fuel cell(SOFC) with its versatile use of fuels has attracted much attention. This was also the case for SOEC, i.e. solid oxide electrolyser cell, which can convert electricity to gas. Although the operational SOFCs were developed in 1980's in the temperature range of 850–1000 °C, they have not penetrated into the market because of the high operating temperatures. Although there are suitable materials that can function at these temperatures, it is very problematic to sustain the required durability and to afford high material cost. Thus, in order to decrease the material cost and to increase the life time of the cell, it is necessary to reduce the operating temperature of SOFC. Therefore, efforts concentrated towards the so-called intermediate temperature solid oxide fuel cells (IT-SOFC), i.e. cell that have acceptable performance at temperatures between 700-500 °C. Electrolyte and anode materials are already available that would function at these reduced temperature, but the main problem is sluggish ORR in the cathode materials. Therefore, efforts to develop IT-fuel-cells amounts to finding cathode materials that would have sufficiently fast ORR.

In this work, we report results from an extensive research program that we have undertaken at ENDAM, METU to develop LSC based cathode materials with an acceptable ORR kinetics [1,2]. The material under study was LSC113-LSC214 composites fabricated via sputter deposition in a wide range of compositions, i.e. 0.10:0.90 < LSC113/LSC214 < 0.90:0.10 using combinatorial approach. The study has shown that the mid-compositions were particularly favorable yielding acceptable ORR kinetics at temperatures as low as 575°C. Cathodes at mid-compositions were either amorphous or nanocrystalline with a very stable performance over extended use.

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Surface charge amorphous salt interaction in composite fuel cells

## Ceramics and Energy: State of the Art in Cathode Materials for SOFC

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The growing world population and the widespread use of personal technological devices cause an increase in the world's energy demand. This demand has been met by the combustion of fossil fuels, which result in the fast depletion of limited fuel resources and enhanced carbonaceous gas emissions that are harmful for human health. Solid oxide fuel cells (SOFCs) are ceramic membrane-based energy conversion devices that can operate either on hydrogen or hydrocarbon fuel gases with efficiencies reaching 80%. This renders them promising alternatives to the conventional energy conversion routes. However, SOFCs are yet to become a commercial success, due to the high cost per power they offer and the long-term instability they exhibit at the operating temperatures of 800 – 1000 °C. These issues can be resolved by obtaining high specific powder density from SOFCs and, if possible, achieving this goal at low operating temperatures (e.g.,  $\leq 700$  °C).

To develop SOFC cathodes that can exhibit high ORR activity, three different approaches of research have been adopted; pursuit of *i*) mechanistic understanding that would later allow the development of new strategies for cathode development, *ii*) novel cathode material chemistries that exhibit high electrocatalytic activity or *iii*) new fabrication methods that would yield desirable microstructures and thus, high electrochemical performance. In this talk, along with a brief literature review, the research of our group at Gebze Technical University on the development of novel SOFC cathode fabrication methods and the microstructure-electrochemical performance relationship they yield will be presented. More specifically, fabrication of single-phase mixed ionic electronic conductor (MIEC) perovskite and perovskite-ionic conductor composite thin film cathodes by polymeric precursor-based methods and the resulting properties will be the focus.

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## Elucidating Microstructural Evolution in SOFC Cathode Processing by Transmission Electron Microscopy

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When it comes to portable, off-grid power, fuel cells are a compelling technology. With an infinite supply of oxygen from ambient air, they will convert chemical potential energy from a fuel, *i.e.* some form of hydrogen, to generate electricity. Despite subverting the need for expensive metal catalysts, solid oxide electrolyte fuel cells (SOFCs) require high operating temperatures to offer impressively high efficiencies. Improving SOFC performance at lower temperatures, while preserving the high energy conversion efficiency, has motivated numerous innovative engineering design solutions for SOFC materials, such as the development of nanocomposite electrodes. One example is a cathode that allows the gas phase to directly contact 2 nano-sized solid phases,  $\text{La}_{0.8}\text{Sr}_{0.2}\text{MnO}_3$  (LSM) and Sm-doped  $\text{CeO}_2$  (SDC), simultaneously. Oxygen is reduced at this 3-phase junction, where it forms oxygen ions with electrons supplied from LSM, and these ions are transported through the SDC percolation path to the electrolyte. Because a longer 3-phase contact line would increase the reaction density, we sought to produce cathodes composed of LSM and SDC nanoparticles. Our hypothesis was that the optimal system could be produced by a Pechini-based approach, by annealing an amorphous, homogeneous gel coating. Our goal was to understand the processing parameters to control the induced crystallization of nanoparticles of 2 phases simultaneously. Thus, for feedback on the microstructural evolution of such a morphologically and chemically complex system, we performed high resolution imaging and spectroscopy analyses on FIB-milled lamellae in a spherical aberration-corrected scanning transmission electron microscope (STEM). Spectrum imaging using characteristic x-ray and primary electron energy loss signals allowed us to evaluate local variations in stoichiometry and segregation due to differences in ionic diffusivity.

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## **Phase transformations of minerals during calcination of Bulgarian kaolin and obtaining products with a commercial application**

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Phase transformations in the calcination of Kaolin EAD's Bulgarian enriched kaolin, mined from Vetovo area, Ruse region, are examined. For this purpose, kaolin is heated to 1350°C and at certain points of the temperature interval (850°C, 1100°C and 1350°C) characteristics of the products obtained – chemical content (RFA), mineralogical composition (XRD), specific density, water absorption, color etc. are determined. The results show that at 850°C the kaolinitic lattice is completely decomposed which results in the formation of a maximum amorphous phase amount without thermal changes in the structure of the quartz. At 1100°C mullite formation starts and at 1350°C mullite, cristobalite, quartz and amorphous phase are registered at the same time. Water absorption, a criterion for the degree of kaolin sintering, logically decreases with increase in temperature, while the specific density slightly rises, and then lowers because of cristobalite phase formation.

The products obtained at these temperatures – metakaolin, calcined kaolin and chamotte, respectively, have specific properties and find application in a number of areas (ceramics, plastics, rubber, paints, coatings, concrete etc).

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## **Firing behavior of the clays used in the clay-based ceramic production**

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The most common type of clay used in clay-based ceramic production e.g., tile, sanitary ware, and tableware is sedimentary origin i.e., “ball clay” that is composed primarily kaolinite accompanied by one or more of the mica-minerals such as illite, chlorite, and montmorillonite. The common clays used in pottery and brick production contains a large amount of illite and little amount of kaolinite. The ball clay and common clay may also contain varying amounts of smectite. The residual kaolin i.e. china clay used in the production of sanitary ware and tableware is well dressed and may contain very low amounts of illite-mica and other oxide impurities and has high crystallinities degree. The natural and industrial mixes of these three main clay classes; i.e., kaolinite, illite, and smectite groups are used together with feldspar and quartz minerals in clay-based ceramic production. The high-temperature phases of relatively pure clays of these three classes have been studied extensively and documented in the literature. The natural and industrial mixtures. i.e., the complex mineralogical composition of the green body makes the high-temperature phases and related physical properties of the fired body complicated and poorly reliable predicting. This work aims to summarize our knowledge about the high-temperature phases and formation sequence in clay-based ceramic bodies derived from the main three classes; i.e., kaolinite, illite and smectite and provides and reliable predicting model for the mineralizing processes taking into account results natural and industrial of mixture of these clay classes used in production . The main intrinsic characteristics e.g., crystallinity degree of kaolinite minerals in kaolinitic clays and the chemical composition of octahedral layer and interlayered cations of illite and smectite minerals have major importance in high-temperature phase formation and formation sequence. The different phases and formation sequences are observed between the ball clay and china clay, between cheto and wyoming type of smectite, between biotite with muscovite type of illite. Besides , the alkaline and earth alkaline elements contents and their concentration gradients and diffusion rates are also major importance newly-formed phases of clay based ceramic bodies.

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## **Modern Material Preparation for the Ceramic Industry: Tried and tested Solutions suitable for processing Slurries and Suspensions**

Various techniques are available for the production of suspensions and emulsions. The machines used for these mechanical dispersing techniques are generally only designed for a certain dispersion viscosity range, and the processing times are long. EIRICH dispersing technology is different. It can be used to process a free choice of viscosity ranges (and consistencies), and this within processing times of just minutes. EIRICH dispersing mixers, which are now also known as MixSolvers®, have been in use for decades in many industries. They are used to process e.g. coating pigments for paper manufacturing, microsilica or pigment suspensions, road marking compounds, printer toner, lithium-ion compounds for rechargeable batteries and spray slip/casting slip e.g. for tiles, sanitary ceramics and technical ceramics, such as dispersions for film casting processes.

For manufacturers of technical ceramics, a special property of the MixSolver® is of particular interest: By virtue of the system, upscaling is very straightforward. This is important because the production process is normally preceded by the development of the formulation in the laboratory. Thus, MixSolvers® are in use in many research institutions and universities, taking advantage of the fact that a process developed for new products can be easily upscaled from a laboratory mixer to a production mixer. In addition, both intrinsically viscous (shear-thinning) and dilatant (shear-thickening) suspensions can be reproducibly manufactured. Here, the purity of the material is preserved, as contamination with abrasion from the parts that come into contact with product is prevented through the use of corresponding linings and armor coating.

**Mechanochemical synthesis and characterization investigations of rare-earth borides and tungsten boride and tungsten silicide powders fabricated from low cost oxide powders**

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Room temperature mechanochemical routes were carried out in the syntheses of nano-sized rare-earth boride ( $MB_6$ ,  $M = La, Sm, Ce$ ) powders from  $M_2O_3-B_2O_3-Mg$  blends, tungsten boride powders from  $WO_3 - B_2O_3 - Mg$  blends and tungsten silicides from  $WO_3 - SiO_2 - Mg$  powder blends. All synthesis reactions were driven by high-energy ball milling and were gradually examined in terms of milling duration and process control agent. Following the mechanochemical synthesis, unwanted  $MgO$  phase and Fe contamination worn off from the milling vial/balls were removed with HCl acid leaching under the effect of ultrasonics stirring. Pure rare-earth boride, tungsten boride and tungsten silicide powders were obtained after repeated centrifuging, repeated washing and drying. Subsequent annealing was performed in a tube furnace under Ar atmosphere in order to reveal residual elements. Phase and microstructural characterizations of the milled, leached and annealed powders were performed using X-ray diffractometry (XRD), differential scanning calorimetry (DSC), scanning electron microscopy (SEM) and transmission electron microscopy (TEM) techniques. High-purity ( $> 99.99\%$ )  $LaB_6$ ,  $CeB_6$  and  $SmB_6$  powders were successfully synthesized having average particle sizes of 80 nm, 86 nm and 81 nm, respectively. Using stoichiometrically excess amounts of  $B_2O_3$ , pure  $W_2B_5$  powders with an average particle size of 226 nm and an average grain size of 55.3 nm were successfully synthesized. Likewise, TEM analysis revealed that pure W silicide nanoparticles with an average size of 97 nm were encapsulated by  $SiO_2$  layers with an average thickness of 15 nm.

## **Inorganic Hole Transporting Materials for Stable and High Efficiency Perovskite Solar Cells**

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Nowadays, perovskite solar cells (PSCs) employing organo-lead halide perovskite absorber materials have attracted substantial attention because of their excellent qualities, such as large absorption coefficient, direct band-gap, high charge carrier mobility, and long diffusion lengths. On the basis of its superior advantages, certified power conversion efficiency (PCE) of 22.7% was achieved. Despite the success in high PCE of perovskite solar cells, there are certain concerns about the poor stability (thermal, moisture and light stability) of perovskite devices that can potentially hinder their commercialization. One of the possibilities of poor stability is the organic hole-transporting materials (HTM) used in device structure due to their hygroscopic and acidic nature. Therefore, instead of organic materials, research of stable and low-cost inorganic materials is very significant for large-scale industrial applications. Since inorganic materials are expected to be more stable than organic ones in terms of high temperature and moisture, a variety of inorganic HTMs have been developed and applied into the PSCs to surmount the drawbacks of organic HTMs. In this review, we have investigated in detail the progress of inorganic HTM-based PSCs and discussed the effect of inorganic HTM on PCE and stability.

**Keywords:** Inorganic hole transporting layer, Stability, Perovskite Solar Cells



## The Production and Characterization of Low Lead Contenting Organic-Inorganic Perovskite Solar Cells

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The main purpose of this study is to prepare low lead content organic-inorganic perovskite solar cell by controlling power conversion efficiency of cell. It proposes the reduction of lead content of organic-inorganic perovskite solar cell. Perovskite is a flexible material that is possible to add many elements in the periodic system ( $\text{Co}^{+2}$ ,  $\text{Fe}^{+2}$ ,  $\text{Mn}^{+2}$ ,  $\text{Pd}^{+2}$  and  $\text{Ge}^{+2}$  etc.). Goldschmidt's tolerance factor ( $t=1$ ) is used to determine which element can be formed stable perovskite structure. The stability and decomposition of perovskite depends on tolerance factor. In the cubic form, the ideal tolerance factor is unity. Therefore,  $\text{Co}^{+2}$  is selected due the unity of Goldschmidt's tolerance factors,  $\text{Sr}^{+2}$  is recommended due to similar ionic Radius to Pb,  $\text{Ca}^{+2}$  that has tolerance factor near to lead based perovskite solar cell, and also the addition of  $\text{Bi}^{+3}$  is proposed that it is successfully used in the lead free composition of piezoelectric materials. First time in the literature, cobalt ( $\text{CH}_3\text{NH}_3\text{Pb}_{1-x}\text{Co}_x\text{I}_3$ ) and bismuth ( $\text{CH}_3\text{NH}_3\text{Pb}_{1-x}\text{Bi}_x\text{I}_3$ ) based organic-inorganic perovskite solar cell will be obtained and their efficiency will be measured. Cell components, photoanodes prepared by spin coated and tape casting, then perovskite structure obtained with adding hole transporting materials and electrodes covered on top of it finally cell is assembled. Electronic properties, band gap and phases of selected composition of targeted cell components will be calculated theoretical first time in the literature. Photovoltaic properties will be measured with standard characterization methods.

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**Ceramic Applications in TÜPRAŞ Refineries for Energy Savings**

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Tüpraş is Turkey's largest industrial enterprise and seventh biggest refining company in Europe, with 28.1 million tones crude oil processing capacity and operating four refineries with more than 5000 employees. Tüpraş R&D Center certified by Turkish Law "Supporting Research and Development Activities" was established in 2010. Tüpraş carries out R&D projects in line with the objective of developing sustainable production strategies alternative fuels, fuel production and energy minimization technologies. A refinery infrastructure mainly is made out of metals however; ceramics also have key roles in daily operation. Ceramic materials such as refractory bricks, thermally stable oxide compounds, catalyst carriers and supports with controlled shape and geometry, coatings and thermal insulation materials are widely used in refineries. Ceramic materials are used in nozzle, seal, valve and membrane components and the places where thermal insulation and corrosion resistance are strictly required. Ceramic based thermal insulation for energy savings is one of a significant application not only for energy dense-industries but also for petroleum refineries. These materials are mainly classified into two parts: traditional (mineral, rock wool etc.) and new generation (aerogel, porous powder etc.). In this talk, refinery ceramics used for energy savings will be shortly discussed and new opportunities for collaboration with universities and companies will be addressed.

## Sacmi technology applied to high-pressure casting cells

Going through crucial steps from casting to pre-drying and final drying regardless of whether traditional low-pressure casting or high-pressure casting is used: finished product quality is preserved anyway. Over the years Sacmi has developed an integrated system which applies various aspects of ceramic technology to high-pressure casting islands and introduces advanced technology to its installations. These include: Structural verification of ceramic bodies, Modelling, Mould management, Feedback product control, Control of pre-drying phase.

**“Sintering behaviours and microstructural developments in oxide and non-oxide ceramics”**

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In this presentations, first basic understanding of sintering mechanisms in ceramic materials will be discussed and sintering behaviours of ceramics will be presented by choosing some examples such as  $Al_2O_3$ ,  $ZrO_2$ , PSZ, AlN,  $Si_3N_4$  and SiC-Si $_3N_4$  systems. Microstructural development will be given by considering the sintering temperatures, powder characteristics (powder size, composition, amount of additives).

Special attention will be given to  $Al_2O_3$ -based and B $_4$ C armour ceramics and their fracture behaviours in real testing conditions.

## High Temperature Processing and Sintering

Uzay ve Havacılık Uygulamalarında Seramik Kaplamalar ve SAÜ-TESLAB Örneği

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Yüksek teknolojik uygulamaların esasını teşkil eden uzay ve havacılık sektörü katma değeri en yüksek uygulamalı bilim alanını oluşturmaktadır. Metalik ve seramik malzemelerin yüksek sıcaklık dayanımının sonuna kadar zorlandığı günümüzde; uzay ve havacılık uygulamalarına yönelik yeni malzeme arayışları devam etmektedir. Sunulan çalışmada; yüksek sıcaklık uygulamalarına yönelik olarak yeni sentez seramik malzemeleri uzay ve havacılık sektöründe kullanılan ısı bariyer kaplamalarına odaklanılmıştır. Termal ve çevresel bariyer kaplamaları konusunda genel bilgi paylaşımı, ilgili üretimlerin gerçekleştirildiği Sakarya Üniversitesi Kaplama Laboratuvarlarının tanıtımı ve imkanları katılımcılarla paylaşılacaktır.

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*“Injectable Bioceramics in Orthopaedic and Dermal Applications”**Levent Mete ÖZGÜRBÜZ**BMT Calsis A.Ş., Ankara/Turkey***ABSTRACT**

Bioceramics can be defined as a group of customized forms of ceramic products that are used in medicine to be able to fix and/or reconstruct the body parts that are damaged or diseased. Injectable bone substitutes (IBS) have been widely used in the last three decades. are mostly preferred for an important advantage: the better ability to integrate and assimilate forming a bond with the bone when compared with the other bioinert or nearly inert compositions. Recent research in the last years have focused on how to take out the regenerative potential and bring out alternative injectable bone substitutes (IBS) constituents that are made of beta-tricalcium phosphate ( $\beta$ -TCP) and hyaluronan for alveolar bone regeneration. In order to correct facial lines (from moderate to severe) and regain the lost volume a type of bioceramics, calcium hydroxyapatite is used as dermal filler worldwide. This talk will be focused on the use of bioceramics in these two different indications.

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## **Newly Developed Lithium DiSilicate Based Glass- Ceramics for 3D Printable Artificial Bones**

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In recent years, there has been an increasing interest in porous fabricated biomaterials that can be fabricated in three dimensions in order to remove hard tissue damage and strengthen tissues<sup>1</sup>. Designed for this purpose, bioactive glass-ceramics are specialized biomaterials, which form strong bonds by reacting with tissues and / or bones<sup>2</sup>. Glass-ceramics containing lithium disilicate are an important milestone in the use of bioactive glass-ceramics as an implant. Lithium disilicate (LiS2) glass-ceramics have superior aesthetic and optical properties, high bending strength (300-400 MPa) and high fracture toughness ( $2.8-3.5 \text{ MPa.m}^{1/2}$ )<sup>3</sup>. These properties, which are superior to other bioactive glass-ceramics, are thought to serve as a skeleton for the formation of new bone tissue and can be used instead of damaged bone tissue.

There are various methods for the production of LiS2 glass ceramics. Commonly used are classical melting method and sol-gel method. In classical melting process, the formation of a fine-grained microstructure is accompanied by an increase in strength and wear resistance<sup>4</sup>. However, there are limitations to the use of this method due to the evaporation of volatile oxides at high temperatures. In sol-gel method, glass porosity can be controlled at low temperatures and glass materials having a much more homogeneous structure than glass produced by the conventional method can be produced. In recent years, with the development of technology, bioactive glass-ceramics production is being done by using 3D printer which is computer aided design and production method. The purpose of the present study is to develop a LiS2 glass-ceramic based system for 3D printing applications of artificial bones.

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## THE EVOLUTION OF DECORATION IN TURKISH ÇİNİ ART

Famous traveller Evliya Çelebi mentioned Çini in his book "Seyahatname", reporting about the beauty and unicity of the Çini articles manufactured by local Kütahya artists in 17th century. Historically the ceramic manufacturers have been producing work in Kütahya since the Phrygian period and continued with çini-ceramic works made with red paste material in the last half of the 14th century. In the late half of the 16th century, Iznik çini art reached its brightest period. In the years after however, İznik manufacturers were severely damaged since they lost the support of the palace and the production of Çini almost ceased to stand.

Initially, Kütahya çinis were produced to meet the needs of the local people and with a more modest quality level compared to the Iznik çinis that were produced. As a result of this situation, the designs of the motifs were arranged and formed with more density. The Çini products were filled with dense motifs and patterns to hide the mistakes and dull background color. In this way; they aimed to mask the quality deficiencies that occur in the çini bisques, the glazes and the colors with intensive pattern designs. The need for intensive pattern designs is one of the most basic features that reflect the characteristic structure of Kütahya çinis. The solution, which emerged as a necessity, was to enrich the motif and pattern designs and increase the aesthetic qualities.

One of the most important problems that the çini producers are facing is; the motifs and designs that directly affect the sale of Çinis are not rich and sufficient in quality and quantity. Therefore, the production of Çinis that are decorated with similar motifs and designs threaten the domestic and foreign markets. Re-interpretation of Çini motifs and patterns went from a contemporary perspective without straying away from the original; it is important to save the Kütahya Çini art which has been going on for hundreds of years from repetition and copies, and to determine a new route in its original line. For these reasons, there is a need for real artists who have internalized the characteristics of Kütahya Çini art.

## PHOSPHORESCENT GLASS

**Ali Ozan Yanar, Hakan Arda, Bekir Karasu**

Eskişehir Technical University, Department of Materials Science and Engineering, Eskişehir,  
Türkiye

### ABSTRACT

Phosphorus is the light-emitting period, sometimes after taking light from an anode source. In the scientific world, new materials that are characterized as phosphorescent with the resistance to heat, atmospheric effects and chemicals have recently been developed. Such a new generation has been extensively researched as long-lasting phosphors due to a growing market for rare earth-enriched alkaline earth silicates and aluminates, glasses, ceramic glazes, resins, brick and tile coatings. In this study, detailed information was given about luminescence, phosphorescence, phosphors, their synthesis, preparation and properties. Additionally, knowledge about phosphorescent pigments, phosphorescent glass and their applications are presented.

**Keywords:** Phosphor, Phosphorescence, Pigment, Glass, Properties, Application.

## High Temperature Properties of SiAlON

Dilek Turan<sup>2</sup>, Alper Uludag<sup>2</sup>, Yağmur Deniz<sup>3</sup>, Sinem Baskut, Serkan Ulukut<sup>4</sup>, Ferhat Kara<sup>1</sup> and Servet Turan<sup>1</sup>

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Silicon nitride ( $\text{Si}_3\text{N}_4$ ) and its solid solutions (SiAlONs) are widely used ceramics for structural applications due to their exceptionally good physical and mechanical properties, such as high wear, hardness and creep resistance. The service life of  $\text{Si}_3\text{N}_4$  and SiAlON materials at a high temperature under stress is limited by deformation over time, which is termed creep. Because of their highly covalent Si-N bonds and low diffusion coefficients, sintered silicon nitrides are usually densified with the aid of additives which form a liquid phase at the sintering temperature promoting solid transport by the liquid phase sintering mechanism. Unfortunately, on cooling, the liquid generally transforms into a residual intergranular amorphous phase whose quantity, distribution and chemical composition control the mechanical properties at high temperature. In order to minimize the amount of vitreous phase, several techniques have been tested such as crystallization heat treatments which improve the creep resistance by limiting the viscous flow in the recrystallized phases. In this study, different heat treatments (AET, BET), different second phase additions (SiC), different additives (Er, Yb and Lu oxides) were used to improve creep properties of SiAlON ceramics. The creep results will be explained in terms of microstructure.

Germiyan SAATÇIOĞLU

## **TÜRK SERAMİK SANAYİİNİ BEKLEYEN TEHLİKE**

### **KARBON EMİSYON TİCARETİ**

Emisyon Ticareti Sisteminin (EU ETS) Avrupa'da doğuşu ve bugüne kadar geldiği safhaları.

Avrupa'da EU ETS'e tabi olan sanayiler, tabi olma kriterleri.

Türkiye'nin emisyon azaltımı için taraf olduğu anlaşmalar.

Türkiye'de emisyon azaltımı için çıkartılmış yasalar, yönetmelikler.

Türkiye'de karbon emisyonlarının azaltımı için yapılan modelleme çalışmaları.

Danışmanlar tarafından tavsiye edilen Emisyon azaltım araçları.

Karbon vergisi, Emisyon Ticareti Sistemi, Yenilenebilir enerji.

Türkiye'de emisyon azaltımı için yasal ve kurumsal altyapı.

Emisyon Ticaretinin uygulanması halinde örnek seramik tesislerine getireceği mali yük.

Seramik Kaplama Malzemeleri Sanayi

Seramik Sağlık Gereçleri Sanayi

Emisyon tahsisleri, bedelsiz emisyonlar,

Emisyon Ticareti Sisteminin getirdiği tehlikeler ve korunma önlemleri,

Karbon Kaçağı uygulaması.

Avrupa'da Karbon Kaçağı kriterleri ve uygulama safhaları

SERES 2018

## **Sustainability and Bench-marking Environmental Impacts in Turkish Ceramic Tiles and Sanitaryware**

**Dr Hüddai Kara, *Metsims Sustainability Consulting, Istanbul, Turkey***

### **ABSTRACT:**

Environmental impacts of construction materials have recently been attracting attention due to fast developments in green building assessment schemes across the world. Measuring environmental impacts such as climate change across the life cycle of a building is becoming an essential part of these assessment schemes. The EU's new Level(s) framework aims to measure sustainability in buildings and communicate to the end users and to facilitate circular economy thinking in construction. Availability of environmental impacts based on life cycle approach of construction materials is an important aspect of these developments.

Turkish Ceramic sector has been very responsive to these developments with product level disclosures using Environmental Product Declarations (EPD). Driven by Construction Products Europe, EPDs are harmonised by EN 15804 norm, and thought to become the foundation of Product Environmental Footprint (PEF) for construction products, a newly developing policy option by the EU Commission. This presentation will bench-mark and show the environmental impacts of Turkish ceramic tiles and sanitaryware per a functional unit and compares against their competitors and draw attention to potential climate change reduction and resource efficiency savings.

**Keywords:** life cycle, construction materials, environmental product declarations, green building assessment, climate change, environmental impacts, ceramic tiles, ceramic sanitaryware

## **UNIMAK SHUTTLE KILNS**

Unimak Shuttle kilns are unique to the market and provide industry leading fuel efficiency.

Our temperature control system is based on the venturi principle.

Fuel efficiency is achieved thanks to a combination of design features that Unimak has developed to give maximum benefit to our objectives and targets:

Burner design is specially selected to give the optimum velocity and power for our heating objectives.

Combustion air supply dynamics are calculated to accentuate the burner venturi affect.

Combustion control equipment is selected to provide the maximum flexibility to reach our goals of homogeneous temperature control.

A waste gas and pressure control system is utilised that compliments the venturi affect created from the combustion system.

Refractory and insulation features of the kiln and the kiln cars provide further enhancement of the circulation of a homogenous atmosphere around the product.

Dedicated software programming has been developed to provide precise control of the equipment.

A SCADA system is used to monitor and record all critical data during each firing cycle, this provides the opportunity to analyse the complete control system and make adjustments to achieve optimum performance and efficiency of the kiln.

## Ceramics and Energy: Thermoelectric Materials

**S. Altin<sup>1</sup>, S. Avcı<sup>2</sup>, A. Bayrı<sup>1</sup>**

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Istanbul Medeniyet University, Dept. of Engineering Physics, Istanbul

In this century, humanity faces the challenge of limited energy sources due to increased energy consumption. Energy problem can be divided into three categories, production, efficient consumption and storage of the energy. Thermoelectric materials is one of the component of the devices which produce electrical energy from the waste heat. The first discovery of the thermoelectricity in the material science has started with metals and alloys such as Te, Sb, PbTe... However, performance of the thermoelectric modules fabricated by alloys decreases with time due to oxidation of the components.

Ceramic thermoelectric materials have better stability in oxidizing environments. Their use enables the fabrication of more durable devices. Therefore, the thermoelectric research have focused on the oxide materials such as p-type NaCo<sub>2</sub>O<sub>4</sub>, p-type Ca<sub>3</sub>Co<sub>4</sub>O<sub>9</sub> and n-type ZnO, SrTiO<sub>3</sub>, and CaMnO<sub>3</sub>..etc.

After discovery of the large Seebeck coefficient for the ceramic material of NaCo<sub>2</sub>O<sub>4</sub>, the scientists have been studying to find new materials. Thermoelectric performance of the ceramics will be reviewed and the future of the ceramics as thermoelectric materials will be discussed.

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## Thermoelectric Materials Modelling

Cem Sevik

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Recent developments in hardware and software computer technologies together with the development of accurate materials modeling techniques enable researchers to accurately model various phenomena observed in materials, prediction of their behavior under different conditions and the development/design of cost-effective materials with improved or desired properties. Nowadays, it is possible to perform such simulations even for a large number of materials using the advantages of new neural network and big-data algorithms.

Efficient thermoelectric materials research, as a topical materials science and condensed matter physics problem, has been a good candidate to be investigated with state-of-the-art materials simulation techniques due to the complexity of the experimental procedure and large number of possible candidate materials. Highly accurate predictions, in particular regarding the effect of defects, grain boundaries, and dimension reduction on both electronic and thermal transport properties have led to discovery of novel thermoelectric materials and new directions to experimental studies on already known thermoelectric materials.

Within the past 10 years, we also have investigated thermoelectric properties of both bulk and nano materials by means of density functional theory and molecular dynamics simulations. Our systematic studies on the in particular controlling the thermal transport properties of the novel nano materials, in order to enhance thermoelectric figure of merit of the materials, have been also one of the pioneering studies in the literature and inspired many new studies. The model interatomic potentials developed within the scope of our TE research effort have been still extensively used in the literature.



## **Nanoscaled bioactive glasses**

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Nanotechnology approaches are being proposed for biomedical applications. Nanoscale bioactive glasses are gaining increasing attention due to their superior bioactivity, enhanced osteoconductivity and antibacterial properties in biomedical applications. The use of nanosized bioactive glasses has advantages in biomedical applications comparing with conventional micron-sized particles. A range of techniques has been using to fabricate nanoscale bioactive glasses including sol-gel, laser spinning, microemulsion and gas-phase synthesis. The produced nanoscale bioactive glasses are being proposed for the design of numerous nanomaterials for biomedical applications, including: combination of nanofibers or nanoparticles with polymeric matrices to produce nanocomposites, incorporation of nanoparticles or nanofibers into porous 3D scaffolds, nanoparticle coatings on implant surfaces and production of non-porous materials containing nanoparticles in the form of gels, injectable materials or hard devices. This presentation covers key technological developments and scientific challenges for nanoparticle and nanofibrous bioactive silicate glasses.

Hilmi YURDAKUL  
Alaaddin Keykubat University, Turkey

Ceramics and Energy: Light Emitting Diodes

## **Developments in Turkish Refractory Industry**

Assoc. Prof. Dr. Ziya Aslanoğlu, RD Director

Konya Selçuklu Chrome Magnesite Brick Co.

Turkey has growing economy. Construction is one of the largest sectors in Turkey. The increase in infrastructure construction activities is the primary driver for the Turkish economy. Refractory material is a key material for the production of steel, cement, lime and glass which is used for construction sector. The refractories industry largely follows trends set by its main driver, steel and cements industries. The steel, cement and lime industries are estimated to account for about 85% of the total refractory market. There is an increase in steel and cement production capacity of Turkey in 2017. Therefore, the demand for refractories is expected to rise from the cement and iron-steel industries. The Turkish refractories market is growing at a moderate pace. The refractory companies are extensively working on enhancing their production capacity, product portfolio and bringing out new, customized products. Despite their crucial role, manufacturers of these products are facing significant challenges from changing global trends. The situation of Turkish refractory industry, effects on the economy and new trends were summarized in this work.

Keywords: Turkish refractory, Refractory materials, development trends,

**series'18**

Davetli Konuşmacılar  
(Sanatsal)

Building a life in art, spending this life on producing original works of art, serving as a model and leading the way. HaniyeColakoglu, who has a privileged place in Turkish arts, left her mark to the national history in 60 years by firing ceramic pulp over a high heat, a material of Plastic Arts which is equivalent to the human history. Her life story which begun in Sürmene/Trabzon in 1933, still remains in Ankara since 1945. Her first gallery on ceramic was hold at Tuna Street in 1957. When her own works on behalf of the ceramics are evaluated by considering its own era, traces of courage and a perspective ahead of her time would be clearly seen as surfaces, forms and monumental ceramics at global line. She is the first female ceramic artist in Turkey who applied firing over a high heat at 1280°C as a work of art and hold exhibitions. Surfaces of her ceramics exist with abstract lines of humanity, unique ceramic shaping compositions and porcelain sculpts. It can be considered that she is inspired by Anatolia's incomparable beauty for each of her piece. From 1950s, she has attached great importance to the developments on Turkish Handicrafts and become a leading artist in this field. She has visited most of the countries in the world and served her accumulation through the arts to her students in an unselfishly way. Mrs. Çolakoğlu is an artist of many parts who has several national and international awards, jury memberships, numerous pieces that have place in museums and collections, a biography by M. SıtkıErinç (1998), hundreds of articles, encyclopaedical information and documents, national and international exhibitions. She is a founder of Hacettepe University Faculty of Fine Arts, Ceramic Department in 1983 and worked as a long-termed chief of the department. She has felt a sense of belonging which composes her artistic stance and identity, in Ankara where she mostly lived in and turned her house in Beysukent near to the university, into a unique Culture House by a will of converting it to a Ceramic Museum in the future.

She presented her most fascinating pieces among the others that she made during her artistic life to Ankara and enriched the city. By her indoor and outdoor ceramic works that enrich the architecture, the building of Hacettepe University, Bilkent University and Land Forces Command lost their simplicities and gained a model structure to be protect in the future. In addition to her contribution to the ceramic arts, she is a leading artist in Turkey, who could bring a culture and perspective to the people and her neighborhood, by the beginning from Yenimahalle where she was born to the whole city. It was impossible for her to stay without changing and beautifying the places around her. Her mentioned characteristics serve as a model by the students that she trained. She is an artist who spreads the art to her whole life and look to the world from this perspective. She is an idol not only because of her ceramic pieces, but also her poems, patriotism, arias, that she sing, friendship with men of culture, family bonds and love. HaniyeÇolakoğlu is one of the most important cultural worker in Turkey. She chose one of the most difficult way in fields of art, cultivating the clay by the fire to make ceramics that she still exists with.

## **In memory of İbrahim Bodur**

### **Mustafa Tunçalp (Turkey)**

I want to Welcome.all of you. Today i want to talk about Mr. İbrahim BODUR which is founder and honorary chairman of Kale Group. He is one of the entrepreneurs and exchange pioneers in Turkey. The first factory of ceramic was established by him in Çan/Çanakkale. Also he is a real visioner. Its been 3 years since he passed away. But still we are so thankful and respectful to him. Also I am pleased, honored and thankful to be here and talking about him too.

I worked with him for 45 years in Kale Group. And it was the golden time of my art career. Because i felt the power of Mr.Bodur and Kale group behind myself every each day.

He never accept ceramic as only art material also he was believing its soul and connection between both. That's why he always supported to art and artists in his whole life. And the important one of these things for us is the ceramic factory which established by Mr.Bodur in 1997 in Çan as i told you before. Over the years many exhibitions have been organized in this museum. And it still continues to be regulated.

İbrahim Bodur wasn't caring only artistic activities, he also was caring many publications. Lots of ceramic artists and painters found a chance of working and researching in this factory and also they have been guest and it made them fell like home. I want to give name some of them; Painter ( artist ) Bedri Rahmi EYÜBOĞLU, my dear teacher Jale YILMABAŞAR, my friend Birgül BAŞARIR, Ceramic artist and my best friend Hamiye ÇOLAKOĞLU. Hamiye always says here is my World and i share it with you and u already inside of my World. Also she made lots of artwork with supported by This factory for 45 years.

Still lots of ceramic artists,especially young artists gets supported by this factory. Still the chairman of Kale group Zeynep Bodur OKYAY supports to artworks and artists. That's why we are still so thankful to Kale Group and Miss Zeynep Bodur OKYAY.

He was gifting many artworks to vip and special guests in every year Also he was taking some artworks to gifting when he was going to abroad. And i was making these artworks for him. He always was caring to artist and artworks as i told you. And it makes us feel better and motivated us.

Today we are here for thanks and showing your respect to him for everything he's done for us. And again i want to say to him thanks for everything you done for development of industry.

Güngör Güner

Süleyman BELEN

## SADİ HOCA

Sadi Diren 1927 yılında İstanbul'da doğdu, 1949 yılında da Güzel Sanatlar Akademisi'ne girdi. Akademiden önce iki yıl kadar Hukuk Fakültesine devam etmiş ve hoşlanmadığı için bırakmış, askere gitmiş ve akademiye girmiştir. Önce iç mimarlık bölümü en sonunda da seramik bölümüne gelerek bu alanda eğitim almaya başlamıştır. Geldiğinde tek öğrencidir, bozuk bir fırın, çalışmayan bir çömlekçi tornası ile başlayan mesleği yıllar sonra onu bugün tanıdığımız Sadi Diren olarak konuşmamıza vesile olmuştur.

Ben öğrencisi, asistanı ve en son halefi olarak sizlere kendi gözümden ve zihnimdeki Sadi Diren olarak size aktarmak istiyorum. Bundan sonra doğal olarak kendisinden Sadi Hoca olarak bahsedeceğim. Kendisi 88 yılı geride bırakmış olan Seramik Bölününün en önemli kişidir. Özellikle 1977 yılında Bölüm Başkanı olmasıyla, Sanayii ile olan yakın ilişkisi, tecrübesi ve sevgisi ile bölümü gerçek anlamda gelıştirmiş ve gerçek bir eğitim ortamına dönüştürmüştür.

Sadi Hoca arkeoloji ve Anadolu Medeniyetleri çok fazla ilgisini çekerdi bellide bu ilgide yakın arkadaşları Prof. Dr. Ufuk Esin'in büyük etkisi ve katkısı olmuştur. Yaptığı sanat çalışmaları büyük ölçüde arkeoloji referansları taşımaktaydı.

Sadi Hoca sanat ifadesinde kullandığı malzemenin dilini en iyi anlamış ve kullanan bir sanatçıydı. Ya pıtlarında yarattığı formlar, ancak seramikten yapılırsa anlam kazanabilecek forumlardı. Bu gün Beni de en çok rahatsız eden hususlardan biri sanat ifadesinin, seramik malzemesini kullanarak farklı bir dille ifade edilmesidir. Hoca da bu durumdan çok rahatsız olduğunu ifade ederdi.

Sonuç olarak yaşantımın 40 yılını aşkın bir süresini birlikte geçirdiğim hocamı saygı ve sevgi ile anarak, konuşmamı bitirmek istiyorum. Huzur içinde Yatsın



**Samar Mogharbel** (Lebanon)

## **STOP MOTION USING CLAY**

The procedure is simple but time consuming and a good editing knowledge is important.

The wet clay is animated and each tiny movement is shot using a digital camera.

The animation procedure is taken into consideration, like the movement, the background, the light ...

A script should be written before hand to synchronize the mouth and expression movements.

The animation should be done quite quickly.

The whole process takes time of the drying of the clay.

Then comes the editing, the voice over and the music, if any...

Many test films are made checked and rechecked, to arrive at the right one.

One very important detail, is the respect of the material and the attentiveness, the clay talks to us and we should go by the flow...

My ideas come from lived experiences and a good crucial observation in real life is transmitted to clay.

## **BLACK POTTERY FIRING SINCE PREHISTORIC TIMES TO THE PRESENT**

Prof. Sevim Çizer (Turkey)

This is one of the most common production way of traditional pottery, where the pots are turned black color by stopping combustion at the end of firing period. This could be in different ways, for example, by smothering the fire with fine dunk, damp grass or branches of trees, sticks of pine trees etc. and then covering all of apertures of kiln.

Sometimes the pots are taken out of the fire and plunged into grass, sawdust , dunk or straw...

There are two main black firing methods:

- Bonfire in 500°- 600°C carbonization – filling into the pores of the clay body.
- Reduction after firing above 800°C and modification of red iron oxide to black iron oxide.

This firing method is still using by the potters in many countries over the world...

## **Wu Ming (China)**

Wu Ming has been engaged in the creation of Zisha clay for more than 40 years, and the poetry and painting as well, setting design, manufacture and carvings in one. He is the earliest person in researching the creation of modern Zisha clay. There are hundreds of articles published and dozens of papers, and more than 20 provincial and national professional awards. His works have been selected into the international ceramics art exhibition of Mino Japan and got the special awards of judges. Many times he has been invited to go abroad to do exhibitions, lectures, and publishing personal monographs. His works are collected by many galleries and museums. His creation inherits tradition, deduces the modern and pays attention to the future, which forms his own style. He has a positive influence on the creation of modern Zisha, and be praised as establishing a precedent and new style in modern ceramics art.

Yixing, the capital of pottery in China, has a history of more than seven thousand years of making pottery. Yixing Zisha was flourishing in the Ming Dynasty. Zisha clay has strong plasticity, it adopts mud insert and flapping molding, the process is unique, the product is rich in shape, and the pot is the main type.

**Fatma BATUKAN BELGE**

## **DOĞU- BATI ARASINDA KÜLTÜREL ETKİLEŞİM VE SERAMİKTEKİ YANSIMALARI**

Seramik; insanlık ve kültür tarihinde çok önemli yer tutan bir göstergedir. Homo sapiens’lerin dünyaya yayılma süreci Neolitik Çağ’da başladı. Bu çağın “akeramik” döneminde besin üreticiliği bilinmesine rağmen pişmiş toprak kaplar henüz yapılmaya başlanmamıştı. Etnolojik araştırmalar yerleşik düzen ile seramik arasında bir bağ olduğunu düşündürmektedir. Seramik ürünler her dönemi yansıtan kültürel göstergeler olarak geçmişe ışık tutmaktadır. İnsanlığa ait ilk belgeler seramik üzerine yazılmıştır.

Geçmişte binlerce yıl boyunca insanlar birbirlerinin kültürlerinden etkilenerек yaşadılar.

Seramik, bu etkileşimi sağlayan ticari etkinlikler içinde alınıp satılan bir obje oldu.

Dolayısıyla insanoğlunun geçirdiği kültürel evrelerin göstergesidir. Doğu ve Batı arasındaki kültürel etkileşim Avrupa’nın dünyanın büyük bölümünü sömürgeleştirmeye başlamasıyla Avrupa-merkezci bir biçime dönüşmüş olabilir. Ancak Avrupa uygarlığı, kendisinden önce gelen kültürlerin katkı ve etkileriyle zenginleşmiştir. Bugün savaş ve çatışmalar, gerici ideolojiler, çağdışı yaşamlarla bir tutulan Doğu coğrafyası bir zamanlar Avrupa’yı etkileyen en gelişmiş kültürleri barındırıyordu. Bernard Lewis, “Bütün kültürlerin kendi kazanımları, kendi sanat ve müzikleri, felsefe ve bilimləri, edebiyat ve yaşam tarzları, insanlığın ilerlemesine başka katkıları vardır; bunların bilinmesinin bize yarar sağlayacağına ve yaşamımızı zenginleştireceğine kuşku yoktur” der.

## HERITAGE/CONTEMPORARY CERAMIC ART

In recent years, the cultural transformation and cultural diffusion within society made me to reevaluate how today's ceramic art is conceived by public.

The question was that "is the rich ceramic heritage create an understanding or is a hinderence to the communication with the contemporary works."

The parameters of traditional values and practices are stated to reveal the underlying aesthetic taste of the viewer . The form and composition methods are bound to strict rules and creativity is expressed through technical perfection and various range of fine decoration which takes the place of content of the work.

The interaction to the ceramic art of today - experimental, without aesthetic concern, rebellious to set rules, critical approach to social and political issues – is analyzed on the light of this heritage on content and on creativity.

BERİL ANILANMERT

## COLOUR IN GLASS ART

This research traces the possibilities of plastic expression regarding to the color of the glass, while ranking the artists who use it by examining the relationship between color and expression in glass. By assigning the meaning to the color perception take place in the scope of the worldwide artists who uses glass in their works.

In the first part, the possibilities of color in glass are mentioned in technical terms, and technical details are mentioned by giving examples of how artists use glass. The studies related to color hereby the transparent structure of the glass are mentioned and the trace of the combination of light and color is traced. Examples are given through the works of the artists who use these features as a bearer. Artists who use color as a bearer on their compositions, and artists who use color monochrome are also mentioned briefly.

**Keywords:** Glass, color, contemporary art, glass art.

Mustafa AĞATEKİN

## **Michael Moore (Ireland)**

### **The Sodeisha Journey**

The 'Sodeisha Journey' presents the journey that created the year long 'Shadow of Sodeisha, Japanese and Irish Art in Clay' exhibition which examined creative links between Ireland and Japan in the year (2017) both countries celebrate their 60th anniversary of Diplomatic relations. The concept began in 2015 when Michael Moore visited the Lafcadio Hearn Japanese Gardens, in Tramore, Co. Waterford, Ireland and initiated a discussion with the Gardens Director, Ms. Agnes Aylward. Lafcadio Hearn (b.1850, d.1904) was a noted poet with strong connections with Ireland and Japan. This discussion between focussed on creative connections between Ireland and Japan. Considering the role of Hearn as a poet and writer based in Ireland and Japan, Moore began to research creative links between Ireland and Japan closer to Ceramics. This led to an examination of the post WW2 artists Group 'The Sodeisha'. The Sodeisha Group were the first group of Japanese artists to consider clay as a material to make abstract art. Such was their influence in general in ceramics and in particular in Ireland, Irish Artist Deidre McLoughlin spent three years in Japan to learn more about Sodiesha. This lay the foundation for the theme of 'The Shadow of Sodeisha'. Moore contacted one of the leading contemporary ceramicists in Japan Hiroaki Morino. Discussions followed with Mr. Morino and Mr. Mitsuo Shoji to develop a selection of artists (6) from Japan for the the exhibition. The selection of Irish artists (6) was made by Dr. Audrey Whitty, of National Museum of Ireland.