**Title:**

# Wearable graphene textile sensors for biopotential monitoring

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**Abstract:**

Electrocardiography (ECG) is a well-established method to monitor the electrical activity of the heart and provides useful information on the heart condition. Conventional method to record ECG involves the use of silver/silver chloride (Ag/AgCl) gel-based, “wet” electrodes placed externally on the skin (usually on the chest and limbs) to measure the electrical impulses of the heart.

However, especially during long-term use (e.g. Holter monitors), the gel-based electrodes can cause skin irritation and discomfort; as well as, potential measurement errors due to drying of the gel. To this end, there has been growing interest to develop skin-compatible, wearable, “dry” electrodes for long-term health monitoring applications. We have addressed this problem by developing a complete prototype of a graphene-textile-embedded wearable medical garment (wristband) with front-end electronics for signal acquisition and wireless transmission.

The graphene-coated textiles were prepared by using a low-cost and scalable technology which involves dipping ordinary fabrics (e.g. nylon, cotton) in graphene oxide (GO) solution, followed by thermal treatment and chemical reduction to obtain graphene cladding around the fibers. Upon preparation, the graphene textiles were sewed directly into elastic wristbands for measurement of the human electrocardiogram in lead-I configuration where one band was worn per wrist. To eliminate bulky data acquisition units, a battery-powered electronic circuitry was built, which is comprised of an analog front-end circuit, an Arduino® microcontroller unit and a Bluetooth module for remote transmission of ECG signals. The electronic circuitry was mounted on one of the wristbands, which facilitated fully wearable and portable ECG monitoring.

The wearable graphene textile-based ECG wristband was compared side-by-side with commercial Ag/AgCl “wet” electrodes, and displayed excellent performance in signal acquisition reaching 97% cross-correlation with those obtained from commercial electrodes. This promising result demonstrates the feasibility of using graphene textiles for weaving smart clothing with integrated electronics for biopotential monitoring.