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Environmentally friendly, biocompatible graphene-based inks for all-printed temperature, deformation, and touch sensors

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The demand for advanced functionalities in electronic devices has been drawing growing attention in the scientific and industrial fields. Printed electronics present the advantages for low-cost and large-scale production, thus being subject of research in a wide range of applications across different sectors, including sensors, actuators, and electronic components. Graphene, a 2D material with exceptional mechanical, thermal, and electrical properties, represents an outstanding candidate for printed flexible electronics. Most graphene inks use organic solvents such as N-methyl-2-pyrrolidone and dimethylformamide, both being toxic, even at low concentrations, which precludes their use in industrial scale production. Therefore, there is an urgent need to replace those solvents by environmentally friendly ones.
In this work, a water formulation was developed with carboxymethyl cellulose, a natural polymer as a binder. The optimized formulation allowed a maximum electrical conductivity of ρ= 1.8×10-2 Ω.m in the conductive patters for printed electronics. The multifunctionality of the inks is demonstrated by being applied in thermosensitive [1], piezoresistive [1] and in an 8 inch touch sensor 2. A maximum thermoresistive sensitivity of S=-0.27, a piezoresistive Gauge-Factor of 1<GF<5 and a signal noise ratio of 10 demonstrate the suitability of the materials for temperature, deformation sensors and touch sensor applications, respectively. The multifunctionality of the materials is thus demonstrated as well as their potential for printed electronics while being both environmentally friendly and biocompatible.

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