Contribution ID: **42** Type: **Poster**

Scalable wax-printing nanoimpregnation method for paper-based sensors and actuators

Friday, 24 September 2021 15:10 (10 minutes)

Paper-based advanced functional materials have become the focus of intense research in recent years. Particularly, magnetic papers show strong potential for applications in a wide range of technologies including communication, magnetic sensing, electromagnetic filtering, magnetic-based health care tools, point-of-care microfluidic devices, and security, among others1,2.
In situ and lumen-loading, the main methods to prepare magnetoactive papers, show problems such as the rigorous reaction conditions, hard control of deposition location, decreased tensile strength, poor retention of magnetic nanoparticles, or the requirement to perform the magnetic impregnation during the papermaking process, that hinder their applicability3,4 . Those issues are addressed in the present work, in which ≈20 nm Fe3O4 nanoparticles are hydrothermally synthesized and later incorporated in a wax-based home-made cartridge and nanoimpregnated into paper by a thermal process leading to a magnetic paper with improved stress and strain at rupture and Young's modulus, 30 MPa, 4.5%, and 2 GPa, respectively, when compared to neat paper, 15 MPa, 3.5%, and ≈1 GPa, respectively. Additionally, the developed magnetic impregnation method provides the paper with a 0.2 emu g−1 magnetic saturation, allowing it to work as a bending actuator with a bending of 12 mm at an applied magnetic field of 105 mT. Such materials and optimized magnetic and mechanical features will enable applications in sensing, actuation, health care materials, or point-of-care devices, among others.

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Session Classification: New principles and technologies for sensing (Posters)

Track Classification: New principles and technologies for sensing