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'Electronic skin' from bio-friendly materials can track human vital signs with ultrahigh precision

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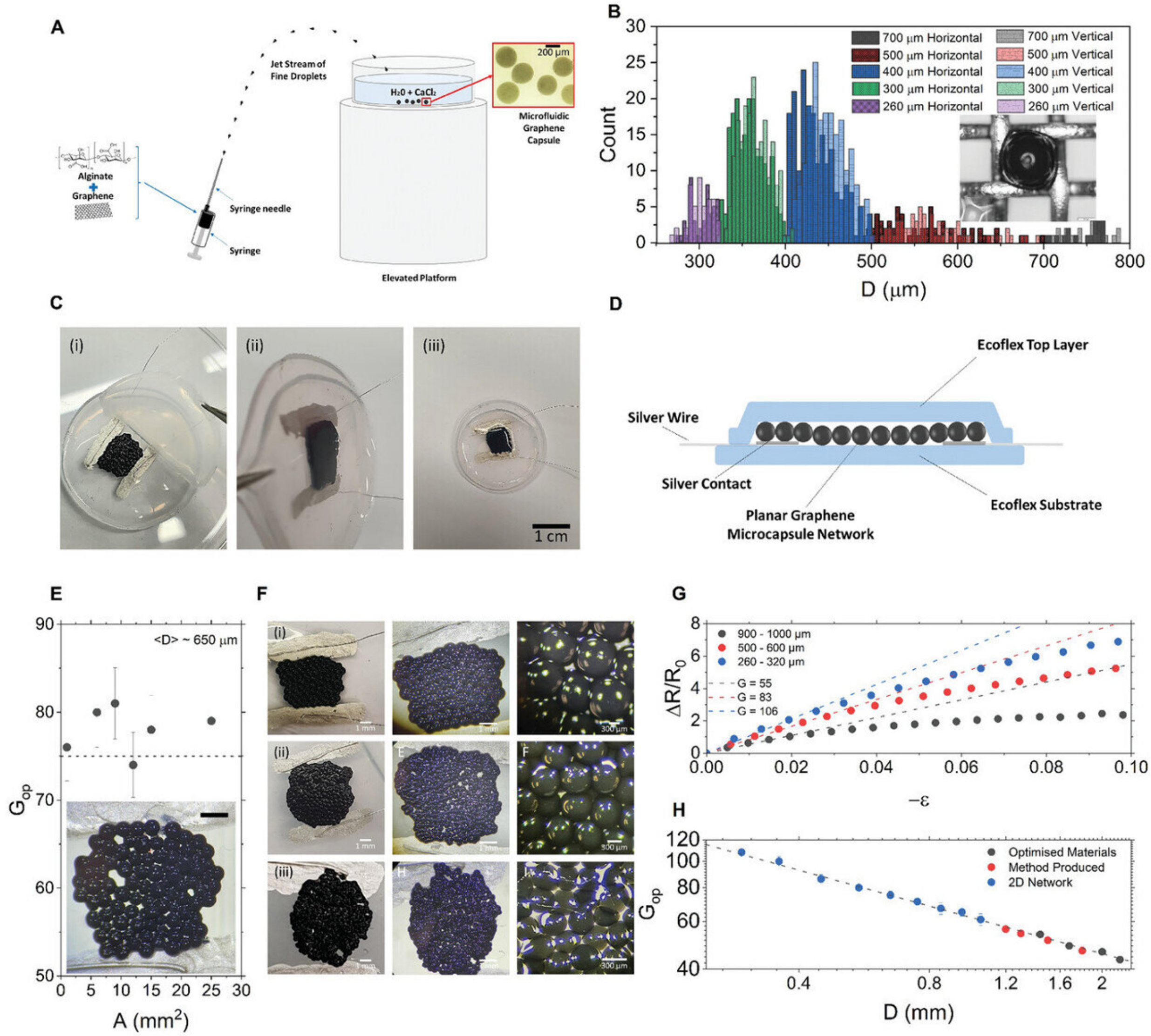

Electronic skins based on quasi-2D microcapsule networks. A) Scheme of graphene microcapsule production through a soft-landing method. B) Mesh-based cascade size exclusion diameter fractions of microcapsules. Inset, optical image of graphene microcapsule trapped by 500 µm steel wire mesh. C) Construction of ≈ 850 µm electronic. i) Capsules are deposited onto a layer of Ecoflex between silver paint contacts and silver wire leads previous adhered to the surface. ii) A thin layer of Ecoflex is then placed across the surface of the sample, fully encapsulating the capsules. iii) A completed electronic skin. D) Scheme showing the cross-section of an assembled electronic skin device. E) Optimized gauge factor for ≈ 650 µm electronic skin was invariant with quasi-2D network areal size. Dashed line is the predicted optimized gauge factor of a single ≈ 650 µm capsule. Inset is an optical image of a ≈ 650 µm microcapsule quasi-2D network (A ≈ 5 mm^2) between to silver electrodes on a Ecoflex substrate, scale bar equivalent to ≈1 mm. F) Optical image collage of different size fraction microcapsule networks: i) 800– 900 µm, ii) 600–700 µm, iii) 260–320 µm. G) Electromechanical response of quasi-2D networks as a function of mean microcapsule diameter making up the network. H) Master plot of optimized gauge factor for all system types in the study. Credit: *Advanced Functional Materials* (2023). DOI: 10.1002/adfm.202303837

Currently much of the research on nanocomposite-based sensors is related to non-sustainable materials. This means that these devices contribute to plastic waste when they are no longer in use. A new study, published on 28 June in *Advanced Functional Materials*, shows for the first time that it is possible to combine molecular gastronomy concepts with biodegradable materials to create devices that are not only environmentally friendly, but also have the potential to outperform the non-sustainable ones.

Scientists used seaweed and salt, two very commonly used materials in the restaurant industry, to create graphene capsules made up of a solid seaweed/graphene gel layer surrounding a liquid graphene ink core. This technique is similar to how Michelin star restaurants serve capsules with a solid seaweed/raspberry jam layer surrounding a liquid jam core.

Unlike the molecular gastronomy capsules though, the graphene capsules are very sensitive to pressure; so, when squeezed or compressed, their electrical properties change dramatically. This means that they can be utilized as highly efficient strain sensors and can facilitate the creation of smart wearable skin-on devices for high precision, real-time biomechanical and vital signs measurements.

Dr. Dimitrios Papageorgiou, Lecturer in Materials Science at Queen Mary University of London, said, "By introducing a ground-breaking fusion of culinary artistry and cutting-edge nanotechnology, we harnessed the extraordinary properties of newly created seaweed-graphene microcapsules that redefine the possibilities of wearable electronics.

"Our discoveries offer a powerful framework for scientists to reinvent nanocomposite wearable technologies for high precision health diagnostics, while our commitment to recyclable and biodegradable materials is fully aligned with environmentally conscious innovation."

This research can now be used as a blueprint by other labs to understand and manipulate the strain sensing properties of similar materials, pushing the concept of nano-based wearable technologies to new heights.

The environmental impact of plastic waste has had a profound effect on our livelihoods and there is a need for future plastic-based epidermal electronics to trend towards more sustainable approaches. The fact that these capsules are made using recyclable and biodegradable materials could impact the way we think about wearable sensing devices and the effect of their presence.

Dr. Papageorgiou said, "We are also very proud of the collaborative effort between Dr. Conor Boland's group from University of Sussex and my group from Queen Mary University of London that fueled this ground-breaking research. This partnership exemplifies the power of scientific collaboration, bringing together diverse expertise to push the boundaries of innovation."

More information: Adel K. A. Aljarid et al, Smart Skins Based on Assembled Piezoresistive Networks of Sustainable Graphene Microcapsules for High Precision Health Diagnostics, *Advanced Functional Materials* (2023). DOI: 10.1002/adfm.202303837

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