Feasibility study on development of soft biosensors based on conductive elastomers

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Quantifying naturally occurring strains in soft materials, such as those of the human body, requires strain gauges with equal or greater mechanical compliance. Strain gauges are devices designed to attach to a target object for the purpose of measuring deformations in a precise manner. The most common type of gauge consists of a patterned metal foil on a flexible plastic backing that attaches to the object with a suitable adhesive, such as cyanoacrylate. Deformations in the object lead to deformations in the foil, thereby causing its electrical resistance to change.

Electrically conductive rubber (ECR) is a promising class of material for this purpose, due to its intrinsically low modulus, low density, elastic mechanics and its pronounced piezo resistivity. ECRs can be prepared by dispersing conductive fillers such as carbon black (CB), carbon nanotubes (CNT) or metallic nanoparticles into elastomers such as poly(dimethyl siloxane) (PDMS). Moulding and curing processes can be used to manipulate such materials, which we refer to generally as conductive PDMS (CPDMS), into desired geometries for device integration. The electrical behaviours of CPDMS, such as the conductivity and the piezo resistance, depend strongly on filler concentration and morphology (e.g., particle size and structure) as well as filler-filler and filler-matrix interactions.

In this feasibility study, all-elastomer strain gauges has been fabricated by with two types of conducting elastomer fibres made by CNT and PDMS integrated in a third, insulating elastomer to form an arrays in the form of thin sheets. It can spontaneously and reversibly laminate onto human skin with the capability for quantifying and spatially distributions of strain. Particularly, when integrated with stretchable electronics and other classes of sensors, these technologies have the potential to expand the range of function that can be achieved in biointegrated systems, with potential utility in wound monitoring, human-machine interfaces and others.