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Soft triboelectric composite generators and sensors

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Triboelectricity has been recently intensively investigated as a simple and cost-effective approach for mechanical energy harvesters and self-powered sensors. Mostly material surface modifications[1-2] and innovative designs for specific stimulation[3-4] were evaluated. We have introduced a totally new generation of triboelectric composites, which can be built with simple processes in any 3D shape, and can be adopted as multi-directional pressure sensors or energy harvesters[5]. In a first stage, a sponge rubber containing conductive disordered wire was addressed. The output power was around 60nW when applying a force with frequency of 2Hz and a produced strain of 45%. In a second stage, we address structural modifications of the composite and of the related fabrication process via a sacrificial layer. This way the generated power can be enhanced of nearly hundreds of times, when creating a suitable air gap solely between the embedded metal wire and the rubber matrix. Specifically, bulk rubber substitutes previous sponge PDMS material, and this aspect contributes to an increase of the surface contact area between rubber and metal. Moreover, the applied mechanical energy is transferred to the wire/rubber interface, rather than being wasted in the sponge. As triboelectricity is widely affected by environmental conditions, here the air gaps are being isolated from the environment, and no encapsulation is needed for the composite. Also, robustness (so durability) is enhanced with respect to the preliminary solution [5]. Therefore, we present a composite as simply composed of a rubber, a conductive wire having small air gaps trapped around, and a reference electrode still placed in the composite and fully in contact with the rubber matrix. Such basic features bring unique properties, i.e. external mechanical stimulations have no need of a preferred surface or direction of application. The reference wire can also be external to the composite or connected to ground. Like in the previous case [5], the generated power is relative to the strain, stress and frequency factors and we will show the relative behaviors. The presented approach can be used in a broad range of inexpensive energy harvesting and/or sensing applications, mainly addressing the wearable and soft robotics fields.

Keywords: triboelectric; soft; composite; generator; sensor

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