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Silk/nano-material hybrid: properties and functions[1] EDEN STEVEN, National High Magnetic Field Laboratory, VICTOR LEBEDEV, ELENA LAUKHINA, VLADIMIR LAUKHIN, Institut de Ciencia de Materials de Barcelona, RUFINA G. ALAMO, National High Magnetic Field Laboratory, CONCEPCIO ROVIRA, JAUME VECIANA, Institut de Ciencia de Materials de Barcelona, JAMES S. BROOKS, National High Magnetic Field Laboratory — Silk continues to emerge as a material of interest in electronics. In this work, the interaction between silk and conducting nano-materials are investigated. Simple fabrication methods, physical, electronic, thermal, and actuation properties are reported for spider silk / carbon nanotube (CNT-SS) [1] and *Bombyx mori* / (BEDT-TTF)-based organic molecular conductor hybrids (ET-S). The CNT-SS fibers are produced via water and shear assisted method, resulting in fibers that are tough, custom-shapeable, flexible, and electrically conducting. For ET-S bilayer films, a layer transfer technique is developed to deposit linked crystallites of $(BEDT\text{-}TTF)_2I_3$ molecular conductor onto silk films, generating highly piezoresistive semi-transparent films. In both cases, the hybridization allows us to gain additional functions by harnessing the water-dependent properties of silk materials, for example, as humidity sensor and electrical current- or water-driven actuators. SEM, TEM, FT-IR, and resistance measurements under varying temperature, strain, and relative humidity reveal the synergistic interactions between the bio- and nano-materials.

[1] E. Steven, et al. Nat. Commun. 4, 2435 (2013).

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