Flexible Solar Yarns with 15.7% Power Conversion Efficiency, Based on Electrospun Perovskite Composite Nanofibers

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ABSTRACT

A flexible perovskite solar yarn with an impressive active lifetime (>216 h) and an exceptional photon conversion efficiency is prepared under ordinary conditions. The champion device demonstrates an average linear mass density of 0.89 mg cm^{-1} and can be bent over a loop diameter of 2.5 mm, with a negligible efficiency loss. Photoactive nanofibers composed of a polyvinylpyrrolidone (PVP) central strain and a perovskite phase on the surface (with average grain size of 275 ± 14.3 nm), are prepared by electrospinning, at 18 kV, relative humidity of 75%, and a temperature of 25 °C. This bilayered configuration promises superior mechanical strength and flexibility, together with an excellent photovoltaic character, compared with their dip coated counterparts. Photoactive perovskite nanofibers are incorporated into a plied-solar yarn, with an organic hole-conductive layer, poly(3-hexylthiophene-2,5-diyl)-coated on silver yarn electrode, and a composite electron conductive layer, phenyl-C_{61}-butyric acid methyl ester ($PC_{61}BM$)-SnO_2 coated on a carbon yarn. An individual double-twisted solar yarns yields 15.7% champion power conversion efficiency, while a 30.5 mm × 30.5 mm active area of plain-woven fabric generates a maximum power density of 1.26 mW cm^{-2} under one sun (1000 W m^{-2}) solar illumination.

KEYWORDS: electrospinning; fiber-shaped solar cells; perovskite–PVP nanofibers; perovskites; photovoltaics

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