Copper-surface Mediated Synthesis of Acetylenic Carbon-rich Nanofibers for Active Metal-free Photocathodes

Tao Zhang
Yang Hou, Shunqi Xu, Zhikun Zheng, Xinliang Feng

Center for Advancing Electronics Dresden (cfaed) and Department of Chemistry and Food Chemistry, Dresden University of Technology, Mommsenstr. 4, 01062 Dresden, Germany.

Tao.Zhang@tu-dresden.de

The engineering of acetylenic carbon-rich nanostructures has great potential in many applications, such as catalysis,[1] sensors,[2] energy storage and conversion,[3] etc. In this talk, we will show a simple and general strategy,[4] namely copper-surface mediated Glaser polycondensation, to synthesis of acetylenic carbon-rich nanofibers. As an example, we demonstrate that poly(1,3,5-triethynylbenzene) (PTEB) nanofibers can be grown on a variety of conducting (e.g., copper, graphite, fluorine doped tin oxide, and titanium) and non-conducting (e.g., Kapton®, glass and silicon dioxide) substrates. The obtained nanofibers (with optical bandgap of 2.51 eV) exhibit photocatalytic activity in photoelectrochemical cells (PEC), yielding saturated cathodic photocurrent of ca. 10 μA cm^{-2} (0.3 - 0 V vs. RHE). By incorporating thieno[3,2-b]thiophene units into the nanofibers, a redshift (ca. 100 nm) of light absorption edge and two-fold of the photocurrent are achieved, rivalling those of state-of-the-art metal-free photocathodes (e.g., graphitic carbon nitride of 0.1-1 μA cm^{-2}).[5] Finally, we will show other examples of acetylenic carbon-rich nanostructures that can be grown on solid substrates by this approach, promise a broad range of applications in energy conversion and storage.

References

[1] Ghosh, S. et al., Nat. Mater., 14 (2015) 505-511.
[2] Lee, J. et al., Nat. Commun., 4 (2013) 2461.
[3] He, J. J. et al., Nat. Commun., 8 (2017) 1172.
[4] Zhang, T. et al., Nat. Commun., (2018) accepted.
[5] Guo, Y. F. et al., Angew. Chem. Int. Ed., 55 (2016) 14693-14697.

Figures

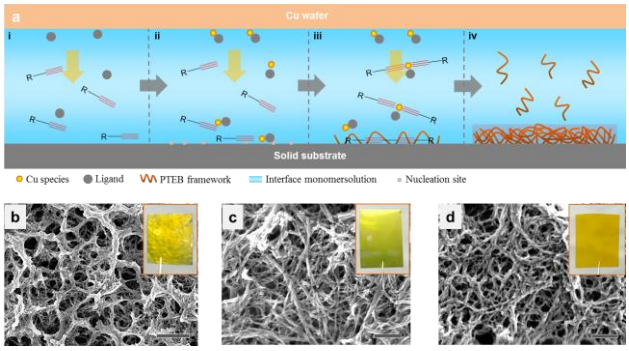

Figure 1: Synthesis of PTEB nanofibers on various substrates. (a) Illustration of the synthetic strategy. PTEB nanofibers can be grown on different substrates: (b) graphite foil; (c) nickel plate and (d) Kapton® foil. Insets: photographs of each sample. Scale bar: (b) 1 μm; (c) and (d) 100 nm.

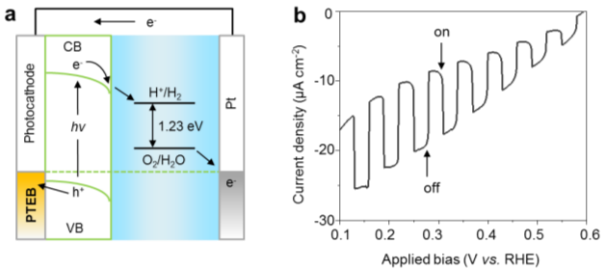

Figure 2: PEC characterization of the PTEB nanofiber based photocathodes. (a) PEC cell with a PTEB photocathode under simulated sunlight irradiation in 0.01 M Na_2SO_4 aqueous solution. (b) Current density-potential curves vs. bias of PTEB under intermittent irradiation.