#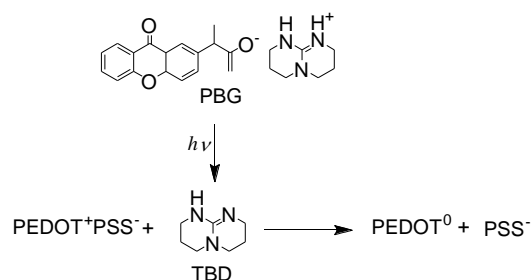 Photoinduced Dedoping of Conducting Polymers: An Approach to Precise Control of the Carrier Concentration and Understanding Transport Properties

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Improvement of the performance of organic electronic devices requires the improvement of electrical properties, such as conductivity, of conjugated polymers. To attain this goal, a better understanding of the physical properties of conjugated polymers as a function of doping level is of fundamental importance. In this presentation, we report the use of a solid-state photoinduced charge-transfer reaction to dedope the highly conductive polymer PEDOT/PSS.

Scheme 1. Photoinduced dedoping reaction of PEDOT/PSS using the photobase generator.

For photoinduced dedoping, a photobase generator is mixed with a conducing polymer so that dedoping occurs upon optical illumination due to the photodecarboxylation reaction in the photobase generator. Scheme 1 presents the photoinduced dedoping reaction exploited in this study. 2-(9-Oxoxanthen-2-yl)propionic acid 1,5,7-triazabicyclo[4.4.0]dec-5-ene salt (PBG; see Scheme 1) is a commercially available water-soluble photobase generator used in low-temperature UV-curing systems. When irradiated at 365 nm, the quantum yield of PBG is high for forming 1,5,7-triazabicyclo[4.4.0]dec-5-ene (TBD). TBD is a strong base with high pK_a values. Thus, doped PEDOT$^+$ should accept electrons from TBD to form neutral PEDOT^0.

By varying the UV-irradiation time, the carrier density in these films is precisely controlled over more than three orders of magnitude. The carrier mobility in the film varies from 10^{-3} to 8.2 cm^2 V^{-1}s^{-1} depending on the carrier density. We attribute this result to the variation in the screening of Coulomb traps from PSS$^-$ at different carrier concentrations. In addition, by measuring the Seebeck coefficient of the film as a function of the UV-irradiation time, we find a maximum power factor of ~42 μW/mK^2 at a carrier density of ~5 × 10^{20} cm^{-3}. Thus, the use of photoinduced dedoping not only provides a platform for understanding the physical properties of conducting polymers but also is useful for developing applications requiring patterned, large-area conducting polymers.

Reference

Q.S. Wei, M. Mukaida, K. Kirihara, Y. Naitoh and T. Ishida, *ACS Appl. Mater. Interfaces*, **2016**, 8, 2054.