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Morphology, Composition and Thermoelectric Properties of PEDOT:PSS films

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Poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) is the most studied conducting polymer system because it is an important hole-transporting layer in organic light-emitting diode (OLED) and organic photovoltaics (OPV), and because of its potential use in transparent electrodes. It is reported by pioneer groups that adding a polar organic solvent into the PEDOT:PSS water dispersion, the electrical conductivity will dramatically increase by more than two orders. Thanks to this approach, the solution processed PEDOT:PSS films show an electrical conductivity over 1000 S/cm, which is approaching to highly doped inorganic semiconductors.

Very recently, several groups reported remarkable high thermoelectric performance by using PEDOT:PSS relying on the high conductivity.[1-4] On the other hands, there are many other concerns in this system such as anisotropy due to morphology[5], humidity-dependent composition change, stability at high temperature and the possible design of the thermoelectric modules by using only PEDOT:PSS.

In this presentation, we will report detailed studies on the morphology, carrier transport properties and thermoelectric properties of PEDOT:PSS films. In the first part, we will discuss the reasons why the addition of co-solvents can significantly increase the electrical conductivity on the basis of morphological studies using grazing-incidence wide angle X-ray diffraction (GIWAXD) and grazing-incidence small-angle X-ray scattering (GISAXS). The carrier transport properties were studied by using ion gel transistors combined with in situ UV-Vis-NIR spectroscopy. In the second part, the anisotropic electrical and thermal conductivity, and the humidity-dependent composition change and thermoelectric properties change will be discussed. Finally, we will show the first demonstration that large area organic thermoelectric modules by using PEDOT:PSS, which can be used to illuminate light emitting diodes.

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