Sulfuric acid vapor treated PEDOT:PSS anodes for ITO-free organic light-emitting diodes

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Indium tin oxide (ITO) is the most popular material with high transmittance and excellent sheet resistance (15 Ω/sq) as the transparent electrode in optoelectronic devices such as organic photovoltaics (OPVs) and organic light-emitting diodes (OLEDs). However, ITO is likely to crack and expensive due to the scarcity of indium on the earth. As an alternative material, poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) is widely used with the advantages of solution processability and high mechanical flexibility [1]. To improve the electrical conductivity of PEDOT:PSS, treating PEDOT:PSS with dimethyl sulfoxide (DMSO) and H_2SO_4 droplets have been reported [2,3]. Although DMSO and H_2SO_4 treated PEDOT:PSS films exhibit a high electrical conductivity, they show a rough surface in order to be used as the electrodes of OLEDs.

In this work, we introduce a H_2SO_4 vapor treatment method to increase the electrical conductivity of PEDOT:PSS thin films. The vapor treated PEDOT:PSS film exhibited much smoother surface morphology than the other treatment. We fabricated typical green phosphorescent OLEDs using H_2SO_4 vapor treated PEDOT:PSS as the anode, and compared the performance with the devices using pristine PEDOT:PSS and DMSO-treated PEDOT:PSS anodes.

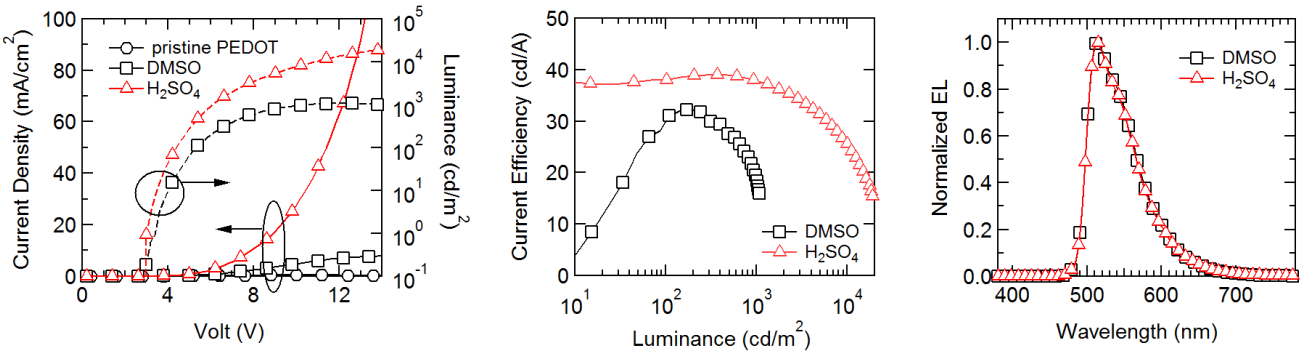

Fig. 1. Device characteristics adopting various anodes with different treatment on PEDOT:PSS

The current densities and luminance of the H_2SO_4 vapor treated device are higher than the control devices as shown in Fig. 1. The driving voltage at 100 cd/m^2 is much lower in the H_2SO_4 vapor treated device (4.4 V) than that of the DMSO treated device (5.4 V). Also, the H_2SO_4 vapor treated device shows higher current efficiency in overall region with the maximum current efficiency (CE) of 39.9 cd/A compared to the DMSO treated device with 32.1 cd/A at the maximum. The electroluminescence spectra of the two devices have almost same peaks at around 510 nm. We believe that this method of H_2SO_4 vapor treatment can be used in a variety of applications as the transparent electrodes for optoelectronic devices.

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