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Cleaning Effect of Indium-Tin-Oxide Substrates on The Electroluminescent Characteristics of Alq_3

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We evaluated the various cleaning methods of ITO substrates such as aquaregia and RCA, using the organic electroluminescent devices with a structure of ITO/TPD/Alq_3/LiAl. And the surface morphology of ITO substrates chemically treated in various ways was also investigated using Atomic Force Microscopy (AFM). It was found that in suitably treated device, both current injection and electroluminescent characteristics of the devices were significantly enhanced.

Keywords: ITO, organic electroluminescent devices, Aquaregia, RCA

INTRODUCTION

Organic electroluminescence devices (OELDs) as a display device have various advantages such as low driving voltage and high luminance[1,2]. Since the organic layer in OELDs is in direct contact with the anode, the device performance is directly dependent on the treatment method of anode surface. Therefore the surface characteristics of ITO substrate has been extensively investigated[3,4]. In this study, various cleaning method of ITO substrate such as aquaregia and RCA was evaluated using the

double layered Alq_3 based OELDs.

EXPERIMENTAL

(a) RCA treatment: the RCA protocol solution was prepared by adding NH_3OH and H_2O_2 into distilled water in a ratio of 1:4:25(60℃).
(b) Aquaregia treatment: A dilute solution was made of HNO_3, HCl and distilled water with a ratio of 1:3:25. And two ITO substrates were spin-coated in aquaregia solution for 30sec, and 60sec, respectively.
(c) Combined treatment: The ITO substrate were treated in a combination of aquaregia and RCA treatments. The OELDs with device structures of ITO/TPD(400Å)/Alq3(600Å) /LiAl were fabricated, where both TPD and Alq_3 were deposited by thermal evaporation in a vacuum chamber with a base pressure of 10^{-6}Torr.

RESULTS AND DISCUSSION

The I-V, and L-V curves of the OELDs having ITO substrates cleaned in various ways are shown in Fig.1 and 2, respectively. It was found in these figures that OELD having ITO substrate treated with RCA followed by aquaregia shows higher luminance characteristics than any other OELDs, where the maximum power efficiency of OELD having ITO substrate treated with RCA was 1.62lm/W, but the maximum power efficiency of the OELD with the untreated ITO was 1.04lm/W.

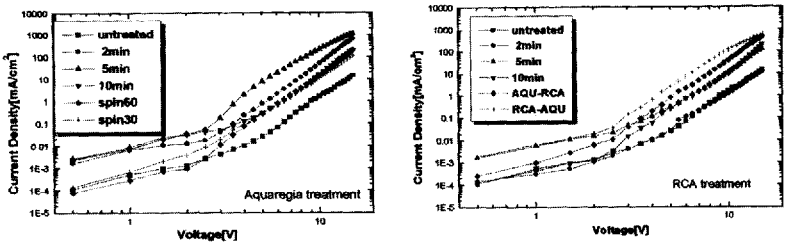

Fig. 1. J(current density) vs V(voltage) characteristics of OELDs having ITO substrates treated in various ways.

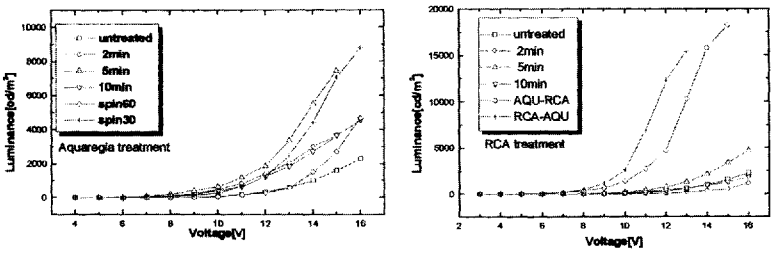

Fig. 2. L(luminance) vs V(voltage) characteristics of OELDs having ITO substrates treated in various ways.

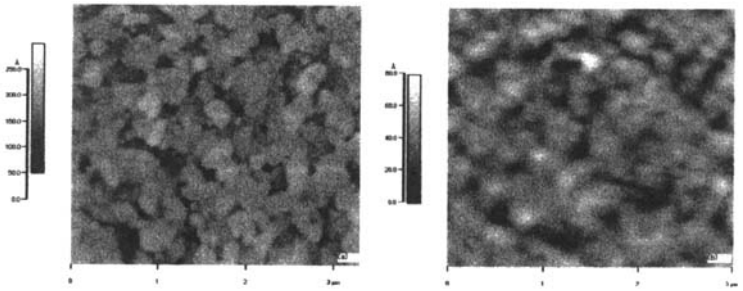

Figure 3 AFM images of (a) untreated ITO substrate, and (b) spin-coated aquaregia treated ITO substrate for 30sec.

Fig. 3. shows AFM images of differently treated ITO substrates in comparison with untreated ITO. The lowest roughness of 7.5, and 8.8 Å was observed with spin-coated aquaregia treatment for 30, and 60sec, respectively, where the average roughness of untreated ITO substrate was 23 Å. It was shown in this figure that the surface morphology of the treated ITO is more porous than that of the untreated ITO except spin-coated aquaregia treatment[3].

In summary, It was found that aquaregia(5min), RCA(5min), spin-coated aquregia(60sec) shows higher luminance, but lower power efficiency than that of the untreated ITO. And spin-coated aquaregia(30sec) and combined treatment were effective in improving the power efficiency of OELD. And spin-coated aquaregia and combined treatment significantly decreases the average roughness of ITO substrates.

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