EFFECTS OF CHEMICAL AND PHYSICAL AGENTS ON THE EMISSION PROPERTIES OF Alq3 FILMS

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In the last ten years organic light emitting diodes, OLED, have been improved to such level of efficiency and reliability [1] that they are seriously considered for next generation of flat panel displays and semiconductor lasers [2]. Among various materials, the metal-organic compound Alq3 is the most utilized one for its excellent optical and physical qualities but, although consistent efforts have been devoted to clarify its many basic and applied aspects, there are still a few properties which await to be fully understood. Indeed, recent spectroscopic measurements are revealing very complex structures in the absorption and emission spectra [3], and the short lifetime of practical OLEDs is still a blocking obstacle in the way of pervasive applications [4].

Degradation of the devices has been attributed to various mechanisms, including crystallization of the organic solids, electrochemical reactions at the electrode/organic interface, migration of ionic species, and electrochemical reactions, but it is well known that the active material itself is extremely sensitive to atmospheric moisture and oxygen [5]. Figure 1 shows the normalized photoluminescence intensity at room temperature, RT, versus time of two identical films of Alq3 kept in air and dry box, respectively. The films, obtained by evaporation under vacuum on glass substrates, have been excited at 395 nm and the emission intensity measured at RT at about 525 nm, as in all the experiments of this work. It is evident that the film kept in dry box is degrading much more slowly than the other one, which is a further indication of the important role played by moisture.

However, one should ask why a freshly evaporated film produces always more or less the same luminescence, irrespectively from the storage age of the starting material. Does the heating during evaporation restore the original optical properties of the material itself? Are the degradation processes reversible with respect to specific reactions? In order to address such important questions, experiments have been performed to probe the effects of chemical and physical agents on the stability of Alq3 films. Figure 2 shows the effects of 10 min annealing in different atmospheres and temperatures up to 250 °C on the photoluminescence at RT of three Alq3 films. As a result, the light emission disappears in the film annealed in air, while no noticeable variations take place in dry nitrogen and dry oxygen. The same experiments have been performed on other three Alq3 films in humidified conditions, and the vastly different results are given in Fig. 3. Firstly, the emission disappears in all three films at different temperatures, but well below 200 °C. Secondly, just before the abrupt decreasing there is an increase, especially noticeable in oxygen and even more in air.

It is evident that the processes of annealing in various atmospheres are producing phase transitions and chemical reactions which are different in the six cases investigated.

These results have been explained on the basis of what is known up to now to mostly, they await to be clarified also by resorting to further experimental research.

REFERENCES


Fig. 1. Photoluminescence of two films of Alq3 as a function of time since the fabrication and later kept in air (open circles) and dry box (black circles). Sample Alq60 are 140 nm thick.

Fig. 2. Photoluminescence of three films of Alq3 annealed for 10 min at each given temperature in different atmospheres as indicated. Samples Alq35 and Alq41 are 30 and 130 nm thick, respectively.

Fig. 3. Photoluminescence of three films of Alq3 annealed for 10 min at each given temperature in different atmospheres as indicated. Samples Alq52 are 110 nm thick.