Towards the mechanism of stabilization of TPD thin films with UV light

A. Tomović[1], N. Markeševič[1,2], V. P. Jovanović[1], R. Zikic[1], M. Scarpellini[3], E. Lucenti[3], P. Milani[3] and V. I. Srdanov[1,3,4]

[1] *Institute of Physics, University of Belgrade, Pregrevica 118, Belgrade, Serbia*
[2] *Huygens Laboratory, Leiden University, P.O. Box 9504, 2300 RA Leiden, The Netherlands*
[3] *CIMAINA, Università di Milano, Via Celoria 16, 20133 Milano, Italy*
[4] *Institute for Terahertz Science and Technology, University of California Santa Barbara, Santa Barbara CA 93106*

Triphenyldiamine (TPD) or N,N'-bis(3-methylphenyl)-N,N'-bis(phenyl)benzdine is a well known hole-transporting material often used in electroluminescent devices. In bulk material glass transition temperature TTPDg ~ 60°C [1] is rather low and for sufficiently thin films (thickness d ≤ 30 nm) deposited on a fused-silica substrate, dewetting occurs even at room temperature [2]. Morphological changes, which are often related to low Tg, lead to degradation of device performance in which thin films are incorporated. That is why it is interesting to find a way to stabilize thin films. Following a brief report [3] on increased stability of UV irradiated TPD films, we focused on elucidating the underlying mechanism, since an explanation of chemical changes on molecular level has not yet been given. Thin amorphous TPD films were produced in physical vapor deposition (PVD) process on a fused silica or glass substrates. Immediately after evaporation one half of each sample was exposed to UV light under ambient conditions in order to compare effects of irradiation on a single film. Illuminated and non-illuminated areas of films are characterized using UV-visible spectroscopy and atomic force microscopy (AFM). Decrease in absorption bands intensity was observed after irradiation, indicating a chemical change in the sample. AFM study clearly shows that dewetting process at room temperature is stopped for irradiated samples thinner than 30nm. Illuminated samples remained stable even after few weeks of storage under ambient conditions and after 24h exposure to temperatures T>TTPDg. From proton nuclear magnetic resonance and mass spectrometry measurements, we find that photo-excited TPD reacts with oxygen from air, which leads to oxidation and hydroxylation of small amount of TPD molecules. We conclude that increased thermal stability of irradiated films is due to hydrogen bonding among TPD molecules and molecules formed in hydroxylation process.

References:

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