日本化学会 第102春季年会 (2022)

有機膜の密度制御とデバイス応用

（九大 I²CNER [1]・理研 RAP [2]）○松島 敏則 [1]・江崎 有 [1]・青山 哲也 [2]・安達 千波矢 [1]

Excellent device performance from higher-density organic films

([1] *I²CNER, Kyushu Univ.*, [2] *RIKEN RAP*) ○Toshinori Matsushima,[1] Yu Esaki,[1] Tetsuya Aoyama,[2] Chihaya Adachi[1]

The influences of film density and molecular orientation on the carrier conduction and air stability of vacuum-deposited amorphous organic films of *N*,*N*′-di(1-naphthyl)-*N*,*N*′-diphenyl-(1,1′-biphenyl)-4,4′-diamine (α-NPD) were investigated.[1)] The substrate temperature (T_{sub}) during vacuum deposition had different effects on the film density and molecular orientation of α-NPD. Film density was a concave function of T_{sub}; maximum density was attained at T_{sub} = 270−300 K [Fig. 1(a)]. α- NPD molecules were randomly oriented at T_{sub} = 342 K, and their horizontal orientation on the substrate became dominant as T_{sub} decreased. Hole current and air stability were clearly raised by increasing the film density by 1−2% [Fig. 1(b) and 1(c)]; these effects were, respectively, attributed to enhanced carrier hopping between neighboring α-NPD molecules and suppressed penetration of oxygen and water. These results imply that increasing film density is more effective to enhance the electrical performance of organic thin-film devices with α-NPD films than control of molecular orientation. Additionally, we demonstrated that performance of organic light-emitting diodes is greatly influenced by T_{sub} [2)].

Keywords : Film density; Molecular orientation; Organic film; Carrier transport; Air stability

有機膜の密度がデバイス特性に及ぼす影響を検討するためのモデル材料として α-NPD を用いた [1)]。様々な基板温度において α-NPD を成膜した結果、その膜密度と分子配向は基板温度に大きく依存した。基板温度が 270−300 K の時に膜密度が最大となることを見出した[Fig. 1(a)]。分子配向に関しては、高い基板温度を用いるほど、面内配向からランダムに変化した。分子配向がデバイス特性に及ぼす影響は明確には観測されなかった。しかし、膜密度の増加は 1−2%であるが、α-NPD 膜に流れる電流と大気安定性が大幅に向上することを見出した[Fig. 1(b) and 1(c)]。膜中の空隙が圧縮されることによって、分子間のキャリアホッピングが改善されたことや、水や酸素が膜中に侵入しづらくなったことが考えられる。また本研究では、有機 EL 特性が基板温度に大きく依存することも見出したので報告する [2)]。

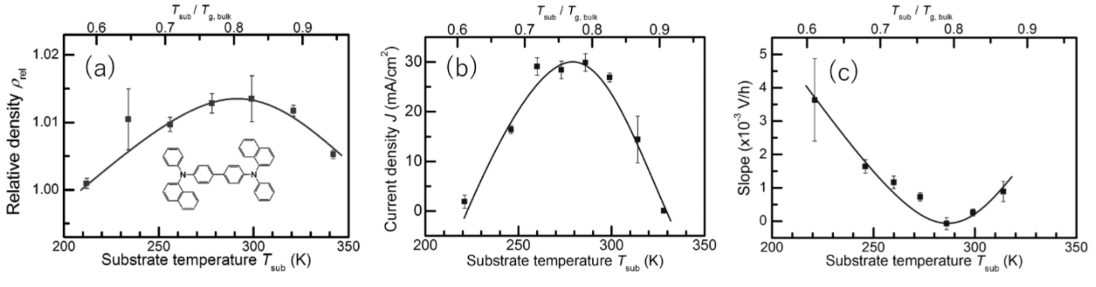

Fig. 1. Plots of (a) film density, (b) current density, and (c) air stability as a function of T_{sub}.

1) Y. Esaki et al., *J. Phys. Chem. Lett.* **2017**, 8, 5891−5897.
2) Y. Esaki et al., *Adv. Electron. Mater.* **2021**, 7, 2100486.