Attempts to explore well-ordered organic heterointerfaces on the organic single crystal surfaces

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Abstract

Organic electronics are attracting growing interest in recent years as one of the most promising next generation semiconductor devices; the power conversion efficiency of the state-of-the-art organic photovoltaics (OPVs) now competes with its inorganic counterparts, high performance single-crystalline organic field effect transistor (OFETs) can be produced with ink-jet printing, and a new paradigm to realize rare-metal free organic light emitting diodes (OLEDs) of very high external quantum efficiency is recently discovered. A common key factor for all these applications is behaviors of the charge carriers at embedded heterointerfaces inside the devices, which is mostly dominated by the electronic structures of π-conjugated organic molecules in contact with another material. However, such interfacial electronic structures have so far been studied on disordered interfaces formed onto polycrystalline or amorphous organic thin films. Probable modification of the molecular orbital levels induced by electronic coupling to the adjacent material is therefore overwhelmed by the structural inhomogeneity. We have been attempting to explore "well-ordered" organic heterointerfaces by adopting the organic single crystal (SC) surfaces as substrates, which is based on our accomplishment to demonstrate the valence band structures of organic semiconductor single crystals by photoemission techniques [1-3]. In this contribution, the electronic structures of two "model" organic-organic heterointerfaces, an alkane ($C_{44}H_{90}$) mono-molecular layer on rubrene ($C_{42}H_{28}$) SC [4] and C_{60} overlayer on pentacene ($C_{22}H_{14}$) SC, will be introduced.

[1] Y. Nakayama, *et al.*, Appl. Phys. Lett. 92 (2008) 153306; *ibid* 93 (2008) 173305.
[2] S. Machida, Y. Nakayama, *et al.*, Phys. Rev. Lett. 104 (2010) 156401.
[3] Y. Nakayama, *et al.*, Appl. Phys. Express 5 (2012) 111601.
[4] Y. Nakayama, *et al.*, Org. Electron. 14 (2013) 1825.