

**Open a door to the mysteries at organic-device interfaces:  
Detection of ultralow density-of-states in the band gap**

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Organic semiconductor has an n- or a p-type charge-transport property that seems to be determined by the molecule itself without intentional electrical doping. A related mystery exists in regard to the energy level alignment (ELA) at organic/organic and organic/inorganic interfaces. Many studies using ultraviolet photoelectron spectroscopy (UPS) have been performed to clarify the ELA mechanism on weakly interacting organic interfaces, and have shown that the vacuum level misalignment and drastic variation of the Fermi level (EF) in the organic band gap appear in various organic interface systems. Because thermal equilibrium concept strictly requires that the Fermi levels of the organic film and the electrode coincide at the interface after contact, our understanding of the ELA mechanism still lacks consistency with this requirement. The mystery on the ELA mechanism must be related to the density of gap states (DOGS) to control the EF. It has been considered for years that gap states due to unknown impurities in molecular packing structures may lead to the answer to the above mysteries. However the experiment has been impossible because of limitation of the sensitivity of UPS.

Here, we introduce (i) direct detection of a very low DOGS that reaches the EF for some organic-device related interfaces with ultrahigh sensitivity and ultralow background UPS, and (ii) a quasi-metallic state appearing in a naphthalene-sandwiched SWCNTs, which consist of curved surfaces.