Molecular Growth and Attenuation of Photoelectron Emission by a Single Organic Layer

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The structural and electron properties of organic-metal interfaces are important for the performance of devices with an active organic layer. Phthalocyanines (Pc) intensively studied in the field of organic electronics. Here we present investigations of the structural and electronic properties of cobalt-phthalocyanine (CoPc) thin-films grown on Ag(100) surfaces. We performed the study using two complementary techniques: photoelectron emission microscopy (PEEM) with a mercury lamp as excitation source and the Anderson method [1]. We identify various stages of CoPc growth [2] by analyzing the evolution of the standard deviation of the electron yield across the PEEM images during the molecular growth and confirm a Stranski-Krastanov growth mode. Surprisingly, the molecular wetting layer is three layers thick. In addition, we show that the first and second molecular CoPc layer on Ag(100) have precursors in the form of a 2D molecular gas. The third CoPc layer grows without precursor.

We correlate the evolution of the mean electron yield obtained with PEEM for coverages up to two molecular layers of cobalt-phthalocyanine with the global work function changes measured with the Anderson method [4] using the Fowler-DuBridge theory [3], as shown in the Figure 1. We find the discrepancy between the transients measured with the Anderson method and those obtained with PEEM after the completion of the second molecular layer. Taking advantage of the fact that the layer-by-layer growth continues up to the third layer, we estimate the attenuation of the electron flux by the third molecular layer. In this way we quantitatively determine the inelastic mean free path of the low-energy electrons as they pass through a single molecular layer.

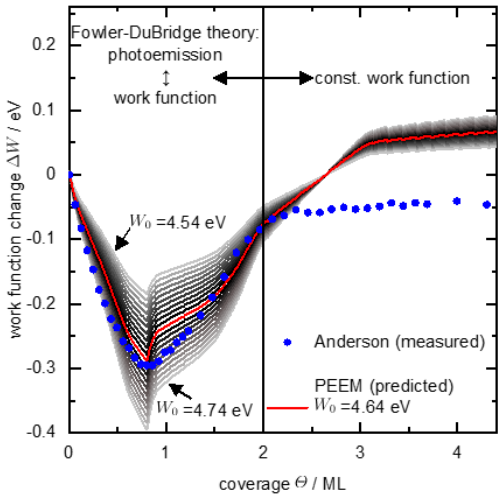

Fig. 1. Growth of CoPc on Ag(100) at RT: Evolution of the work function changes determined with the Anderson method and from electron yield measured in PEEM

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[1] A. Sabik, F. Gołek, G. Antczak, Review of Scientific Instruments **86**, 056111 (2015).
[2] T. Wagner et. al, Ultramicroscopy **233**, 113427 (2022).
[3] L. A. DuBridge, Physical Review **39**, 108-118 (1932); L.A. DuBridge, Physical Review **43**, 727-741(1933); R. H. Fowler Physical Review **38**, 45-56 (1931).
[4] T. Wagner et al, ACS Appl. Mater. Interfaces **14** 23983−23989 (2022).