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In-situ growth study of gold nano-domains on P3HT films for hybrid solar cells

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For fabrication of a top electrode in a hybrid solar cell, a metal thin film is deposited on the organic hole transfer layer in the cell, and a polymer/metal interface is formed. To deposit the electrode layer, sputtering is preferred as compared with vapor-deposition method, because of the metal wetting behavior when it grows on the polymer, which leads to a better contacting between metal and polymer and a more homogenous metal electrode.
In our experiment, by sputtering, a gold layer is deposited on poly-(3-hexylthiophene) (P3HT) thin films, both with and without Li+ doping. The polymer films are on Si substrates. To better understand the morphological evolution of the gold layer during the deposition process, in situ grazing incidence small-angle X-ray scattering (GISAXS) is applied. By analyzing the 2D GISAXS data from the in-situ measurements the growth models can be accessed. Two different growth models, 3D cluster growth and 2D layer by layer growth, appeared during the sputtering process. By analysis of horizontal line cuts from the 2D GISAXS data in-plane structures are probed. During the early stages of sputtering, the lateral growth rate of gold clusters is relatively high according to a dramatically change of the periodic distance, and the sizes of gold clusters are broadly distributed. With the increasing of sputtering time, the sizes of the gold clusters trend to become constant. The samples with and without doping exhibit slight differences in their morphological evolution. However, the trends of the morphological evolution are similar. The vertical growth rate of the gold films can be gained by analysis of vertical line cuts from the 2D GISAXS data. In the initial stage a smaller growth rate of sputtering on P3HT than directly on SiO2 substrate is found. Thus 3d cluster growth of gold particles on P3HT and gold diffusion in the P3HT layer also appeared.

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