

## TOWARDS CONTROLLED BOTTOM-UP ARCHITECTURES IN ORGANIC HETEROEPITAXY

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The last decade has witnessed an increased interest on the development of devices based on semiconductor organic materials. Yet, the present day-knowledge that enables the controlled growth of organic architectures is in an early stage. Moreover when sequential deposition of two organic materials is involved (organic heterostructures), as required for multilayers or p-n heterojunctions.

Here we report a study on the growth of organic heterostructures combining diindenoperylene (DIP), which shows preferential p-type conduction, with fluorinated copper-phthalocyanines ( $F_{16}CuPc$ ), one of the few air-stable oligomers showing preferred n-type conduction. The heterostructures are grown in form of bilayers, by depositing films of one of the molecular species onto Si/SiO<sub>2</sub>, and using it as substrate for subsequent deposition of the other molecular species. Both deposition sequences have been studied as function of the growth temperature by in-situ X-ray scattering and atomic force microscopy (AFM).

When DIP is deposited onto  $F_{16}CuPc$  above a threshold substrate temperature of 90°C, the formation of highly crystalline DIP islands takes place via Stranski-Krastanov growth. Their growth is intimately related to a novel type of reconstruction of the underlying organic film, which affects three monolayers adjacent to the organic interface.[1] Below 90°C, the reconstruction of the underlying  $F_{16}CuPc$  does not take place and DIP follows a close layer-by-layer growth. The temperature dependence of the growth behaviour can thus be exploited to control the resulting morphologies, ranging from well ordered layered heterostructures to the self-organization of highly crystalline DIP islands with tunable size and density (Figure 1).

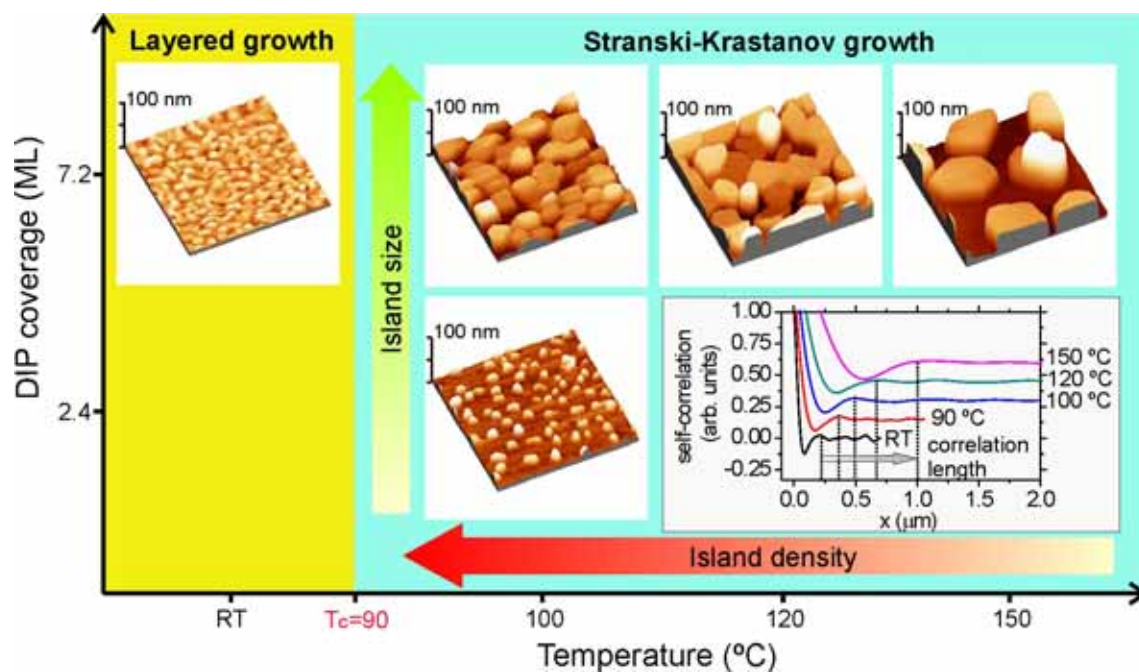
Deposition in the opposite sequence, i.e.  $F_{16}CuPc$  on DIP, differs from the previous case in the sense that well ordered layered heterostructures form independently of the growth temperature. However, while  $F_{16}CuPc$  deposited at low temperature orders in the known  $\beta$ -structure,[2] at high temperature  $F_{16}CuPc$  grows with the same structure as that of the reconstructed layers below DIP in the case of DIP on  $F_{16}CuPc$  at high T.

In spite of the close resemblance with the formation of semiconductor nanostructures for inorganic heteroepitaxy, the present results conclusively demonstrate a distinctly different growth mechanism for organic heteroepitaxy.

### References:

[1] Esther Barrena, Dimas G. de Oteyza, Stefan Sellner, Helmut Dosch, J. Oriol Ossó, Bernd Struth, Phys. Rev. Lett., **97** (2006) 076102.

## Figures:



**Figure 1.** Morphology of the heterostructures consisting in DIP on  $F_{16}CuPc$ , grown at different temperatures and with different DIP coverage. All images show areas of  $2 \times 2 \mu m^2$  and are plotted according to the same z-scale bar, in order to allow a better comparison among samples. The colored arrows indicate the tunability of island size and density by the appropriate choice of growth temperature and DIP coverage. The self-correlation functions of the different samples give further evidence on the increasing correlation length with temperature.