ESRF	**Experiment title:** **XPCS Analysis of Non-Equilibrium Dynamics Underlying the Growth of Molecular Thin Films**	**Experiment number:** **SC-5196**
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Report:

Description of the experiment

In this experiment, we were growing thin films of an organic semiconductor, pentacene (PEN), using the molecular beam deposition technique. During the film growth, we were measuring the coherent X-ray surface diffraction to analyze it with X-ray photon correlation spectroscopy (XPCS).
The film growth was performed in our own ultra-high vacuum deposition chamber that we brought with us. We installed the chamber on the diffractometer in the experimental hutch, and the Eiger 4M detector was placed five meters downstream from the sample. Furthermore, we used the water cooling for the thickness monitor and liquid nitrogen cooling of the substrate using the beamline's infrastructure. The temperature controllers and power supply units for heating of the crucible with the organic material and the substrate were installed in the control hutch and connected to the chamber via long cables.

Preliminary results

We grew several PEN films with a thickness of 15-20 nm at different substrate temperatures, i.e. two different low temperatures (T_{SUB} = -120 °C) and (T_{SUB} = -50 °C), and room temperature (T_{SUB}=40 °C).

After the growth the films were heated up in steps to ~200 °C until they were evaporated. During this whole procedure, we were measuring XPCS scans with one second acquisition time and one second break, to avoid beam damage.

During the growth of the first 1-5 molecular layers of the PEN film, we observed the formation of small molecular islands (Fig. 1, left). This effect causes some interesting features in the two-time correlation function (Fig. 1, right). The speckle contrast of the measured diffraction patterns allows us to reliably determine characteristic time scales of our system using the decay of the g_2 functions.

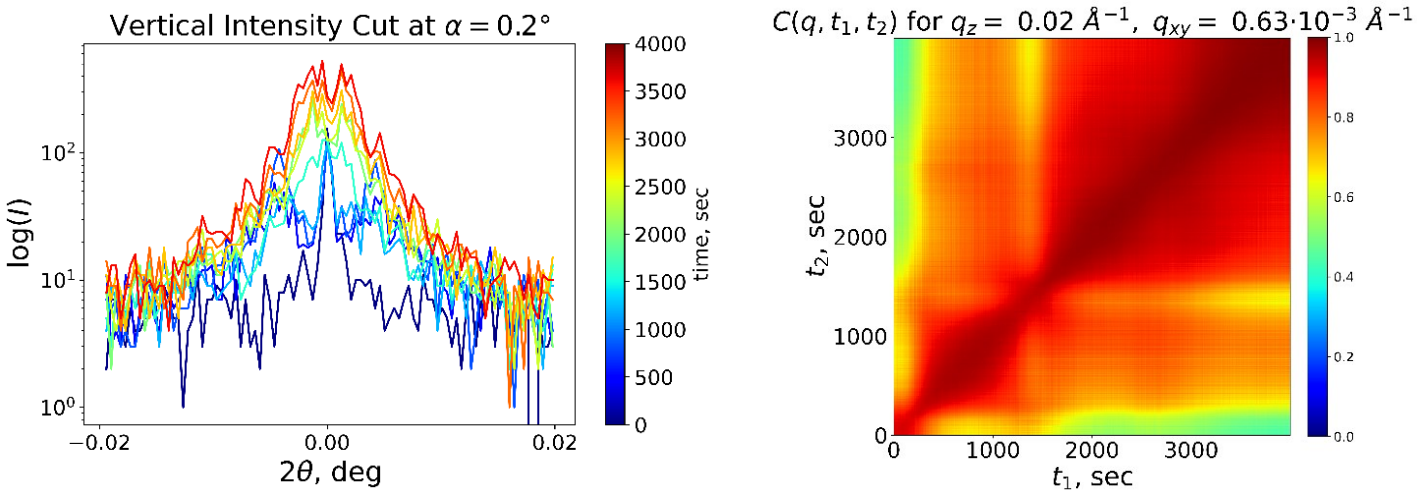

Fig 1: Development of a vertical intensity cut during the growth of a PEN film at room temperature (left). The formation of correlation peaks is visible in the beginning, but after ~1500 seconds they disappear. Next to it is the corresponding two-time correlation function $C(q, t_1, t_2)$. Some interesting features appear while the correlation peaks are formed, afterwards the system slows down.

Conclusions

We successfully performed an in-situ XPCS measurement during the organic molecular beam deposition. During the growth of a series of PEN films at different substrate temperatures we observed the evolution of the film surface during the growth and subsequent annealing of the films. The beamline scientist from ID10 (F. Zontone) will be included in the publications resulting from these measurements.