

EUROPEAN SYNCHROTRON RADIATION FACILITY



	Experiment title: In-situ gold sputtering on top of 6-Phenacene thin films	Experiment number: SC-5222
Beamline: ID10	Date of experiment: from: 21.06.2022 to: 27.06.2022	Date of report:
Shifts:	Local contact(s): Martinelli Lucio	<i>Received at ESRF:</i>
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Report:

1. Experimental Procedures: We have studied the growth processes of organic semiconductors as well as gold metals with organic molecular beam deposition (OMBD). The experiment was performed at BM32, which offered a UHV environment to do organic as well as metal deposition, and was fitted with a beryllium window to make x-ray experiments possible. The deposition rate and substrate temperature were controlled from the hutch. A quartz crystal microbalance (QCM) was used to observe the deposition rate of the molecules. Measurement with x-ray reflectivity (XRR) as well as grazing incidence wide angle x-ray scattering (GIWAXS) were performed with a detector. The experiments were performed at an energy of 11.19 keV and a sample detector distance of 700 mm. We used XRR for in-situ measurements. GIWAXS was performed by using the same detector and varying its position and was only used for postgrowth measurements.

The experiment was performed by using pre-deposited samples with [6]Phenacene from our home laboratory. The samples were already mounted and the gold cell was already calibrated by our local contact before the beamtime. After reaching our desired evaporation temperature molecules were evaporated while doing in-situ XRR imaging. After postgrowth imaging the sample was changed and the experiment was repeated with different films/conditions. The second part of this experiment was performed by using empty substrates and the already pre-installed [6]Phenacene cell. Pure films of [6]Phenacene were grown while measuring in-situ XRR and after postgrowth measurements, the gold deposition from above was repeated with these “fresh” films.

A total of 11 complete films were deposited and we have acquired real-time measurements of 16 depositions (pure deposition + gold deposition + pre deposited films) during our beamtime.

2. **Difficulties:** On arrival everything was already pre-installed and aligned so we were able to start our experiments right away. We also had one beam loss during the deposition which lead to a data loss of 30 minutes. Due to a intervention the beam was not available for several hours. Fortunately this happened not during an experiment and we were given an short beamtime extension on Monday to complete our measurements.

3. **Achievements:** The goal of our experiment has been accomplished. Our data is still under evaluation, but we think the data is sufficient for one publication.

Figure 1 shows the in-situ deposition of 20 nm of gold on top of [6]Phenacene.

Compared to pure [6]Phenacene, the film shows a different roughness while the main out of plane crystal structure of [6]Phenacene stays intact. The data was then evaluated by using a Gaussian on the first (002) bragg reflection. The results comparing the base 10 and 20 nm base films are shown in figure 2 and 3. Both depositions of the base ([6]Phenacene) film show a slight variation which can be explained by fluctuations during thin film growth.

However the overall trend shows a sharp decrease in lattice spacing during the initial stages of thin film deposition due to a strong molecule-substrate interaction that changes into a molecule-molecule interaction. After a small amount of gold a slight decrease of lattice spacing is observed due to the additional gold molecules on the thin film surface. The overall trend is a slight increase of lattice spacing during gold deposition which seems to have a critical thickness around 10 nm of gold which then changes into the opposite direction.

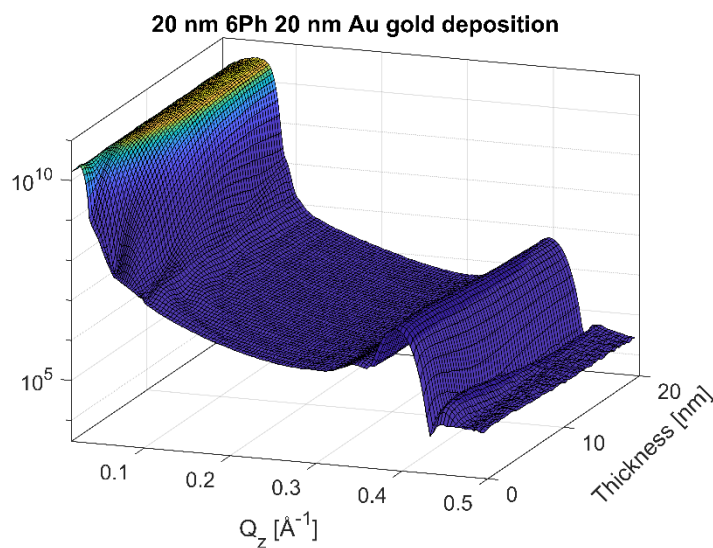


Figure 1: XRR measurement of 20 nm of gold on top of [6]Phenacene

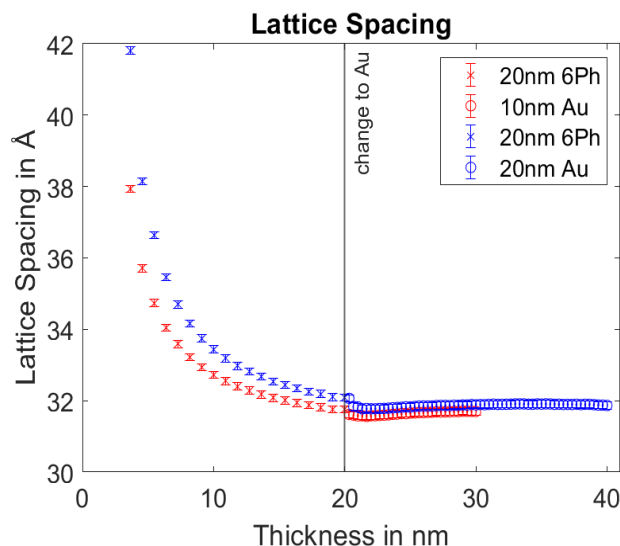
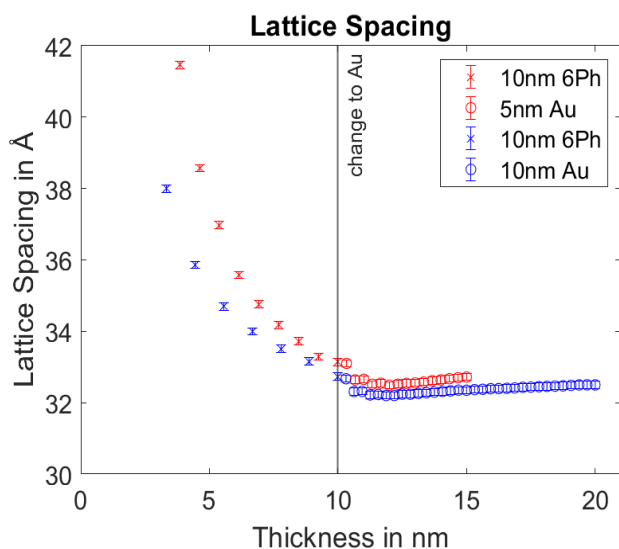


Figure 2 and 3: Lattice spacing evolution during the deposition of pure [6]Phenacene and gold on top of it. The left image shows the 10 nm base film and the right one the 20 nm base film. Each left side shows the deposition of [6]Phenacene and the right side the gold deposition.

4. **Acknowledgements:** We would like to thank M. Lucio for his excellent support as a local contact during the experiment and the control room team for their flawless intervention before the weekend to ensure a stable beam during the experiment.