In-situ characterisation of graphene grown on a liquid copper surface via Raman spectroscopy and optical microscopy

Wojciech Ryś[1,2], Maciej Jankowski[2], Francesco La Porta[2]

[1]Department of Molecular Physics, Faculty of Chemistry, Lodz University of Technology, Zeromskiego 116, 90-924 Lodz, Poland
[2]ESRF−The European Synchrotron, 71 Avenue des Martyrs, 38000 Grenoble, France

The research for easy, cheap and controllable graphene production is currently receiving much attention. The CVD growth of two-dimensional materials on liquid metal catalysts is a promising route towards the controlled fabrication of graphene. Compared with the growth on solid substrates, it results in high-quality crystals, their faster growth rate and low nucleation density. This work aimed to study the CVD growth of graphene on a liquid copper substrate using in-situ Raman spectroscopy and radiation-mode optical microscopy that allows tailoring the growth conditions in real-time [1].

The CVD growth was done using a prototypical reactor developed during the Liquid Metal Catalysis (LMCat) project [2]. Its design allowed studying the ongoing reactions by combining radiation-mode optical microscopy, Raman spectroscopy and synchrotron X-ray diffraction. Furthermore, the real-time observation with the microscope allowed studying and tailoring graphene growth dynamics by adjusting the precursor gas pressure and composition in order to achieve desired nucleation density and the size of graphene flakes.

The Raman measurements were done above the copper melting point and at room temperature. The data analysis allowed to obtain information about the quality and number of grown graphene layers.

The analysis of Raman spectra recorded from the graphene grown on liquid copper shows only a tiny D band peak, evidencing the minor presence of defects, even after cooling and copper solidification. The spectra allowed differentiating between mono and multilayer graphene, confirming its successful synthesis for both cases. All the presented results show a possibility for cheap and straightforward, in-situ characterisation of graphene growth on molten metals at elevated temperatures.

[1] Jankowski, M. et. al, ACS Nano. **15**, 9638-9648 (2021).
[2] Saedi, A. et.al, Rev. Sci. Instr. **91**, 013907 (2020).