Growing perfect graphene on a liquid metal: from self-assembled flakes to the single layer

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The aim of the LMCat (liquid metal catalysis) EU Horizon 2020 project is to deliver an instrumentation and methodology allowing to study *in situ* and *in operando* the growth of 2D materials (2DMs) on liquid metal surfaces.

The current approach to graphene (Gr) synthesis generally relies on CVD growth on solid substrates, mainly copper. Despite recent progress and fine-tuning of growth procedures there are significant obstacles in transferring the current knowledge towards mass production of good quality sheets over large-scales. The main showstoppers are slow procedures of 2DMs separation from solids, their environmental unfriendliness, and low quality of produced layers. All these factors significantly impact process costs, speed, and waste production.

In this contribution we will present the first experimental results of graphene growth on liquid copper in a newly developed CVD reactor, dedicated to the study of chemical reactions on LMCats. By combining *in situ* synchrotron X-ray diffraction and optical microscopy, supported by *ex situ* Raman spectroscopy, we are capable to resolve in *real-time* the growth dynamics and atomic structure of graphene during its growth on liquid copper. Contradictory to solid, this later is an atomically smooth, isotropic and mobile medium, which allows to produce graphene crystals of extremely high-quality and large sizes limited only by the liquid bath surface. A myriad of interesting growth scenarios was observed which allowed to fine-tune the fabrication procedures and to identify key factors impacting the growth of individual flakes, their self-assembly and further association into a single layer with a coherent atomic structure

The obtained results are indispensable for establishing the methodology for the continuous production of graphene sheets on LMCats and pave a new way for the future cost-effective and large-scale fabrication of 2DMs.

References

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Figures

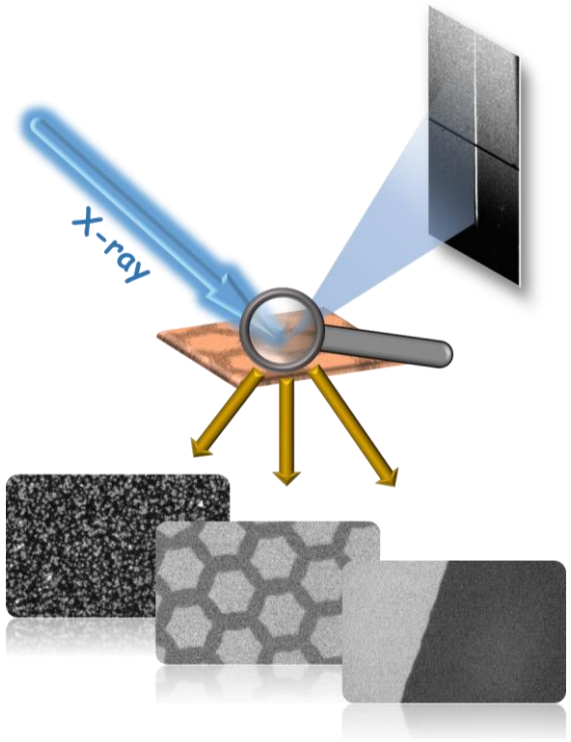

Figure 1: Diffraction rod of 2D Gr crystal on liquid-Cu recorded using synchrotron X-ray diffraction (top), optical microscope snapshots recorded during the growth of Gr (bottom).