Next generation of transparent conductive films by electrochemical exfoliated graphene deposited by interfacial self-assembly.

Borja L. Sanchez[1]
Guillermo Hernanz[1], D. Rodríguez-San-Miguel[1] and Félix Zamora[1]
1. Deparment of Inorganic Chemistry Universidad Autónoma de Madrid, Madrid, Spain
Borja.sanchez@uam.es

Nowadays, everyone uses electronic devices such as smartphones, smartwatches, smart TVs, and other product like smart windows, touch panels, OLEDs, and photovoltaics devices. All of them have a critical common component: transparent conductive electrodes (TCEs), which must possess two essential qualities: high optical transparency and electrical conductivity. The global market prospects for TCEs were $5 billion in 2020 and are projected to reach $13 billion by 2030 [1]. Currently, indium tin oxide (ITO) is the most widely used material in TCEs, with a sheet resistance of ~ 70 Ω^{-1} and optical transmittance around 90 %. However, indium is a scarce element, and the high production temperature of ITO films and brittleness prevent their use for flexible applications [2]. Graphene thin films are excellent candidates due to their outstanding properties, including high electrical conductivity and transparency across the entire visible region through the far infrared. We propose solution-processed electrochemical exfoliated graphene as one of the most attractive approaches for future TCE, due to large-area scaling and low cost. Among liquid phase exfoliation (LPE) techniques, electrochemical exfoliation (EE) [3] produces impressive results of aspect ratio and yield, which can be maximized by following it with a suitable deposition method such as interfacial self-assembly [4,5], which forces the graphene flakes to align at the interface between two solvents. We have prepared graphene nanosheets tiled coatings few nanometres thick using Langmuir-Schaefer deposition of EE graphene. This simple and low-temperature protocol produces EE graphene coatings with high optical transparency and electrical conductivity, making them strong candidates to replace ITO in future flexible electronics and wearable devices.

References

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Figures

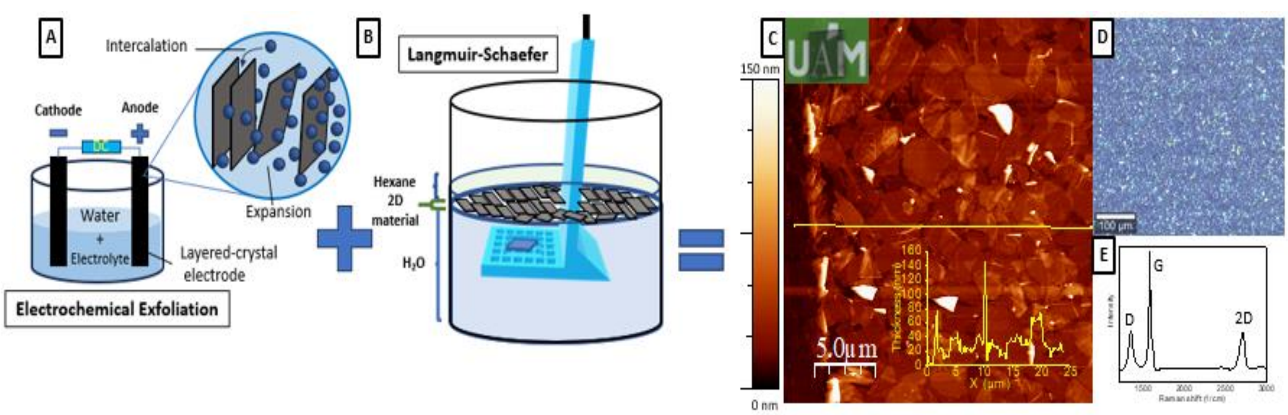

Figure 1: A) Scheme of electrochemical exfoliation; B) Scheme of homemade Langmuir-Schaefer set-up; C) Atomic force microscopy and D) Optical images of tiled EE graphene coating; and E) Raman mapping average of tiled EE graphene coating showing the high quality of the exfoliated graphene.