2D Device Fabrication Solutions: Low Damage Plasma Atomic Layer Deposition on 2D Materials

Sarah Riazimehr
Oxford Instruments Plasma Technology UK, North End, Yatton, Bristol, United Kingdom
Sarah.riazimehr@oxinst.com

In recent years, extensive research has been conducted on two-dimensional (2D) technologies, resulting in their gradual improvement for practical applications. The large amount of data collected, and the impressive performance of the devices demonstrated confirm that 2D materials are promising candidates for applications in electronics, photonics, and sensor technology. However, the transition of these materials from research to widespread industrial use requires the development of robust manufacturing processes to produce devices at competitive prices[1]. An example of these key challenges is the integration of 2D materials with dielectrics[2], which is essential for the development of next-generation devices.

The deposition of dielectric materials on 2D materials poses a significant challenge due to compatibility issues between 2D layered materials and conventional 3D dielectrics. To address these challenges, Oxford Instruments has been developing laboratory and manufacturing technologies for the unique characteristics of 2D materials. This presentation will provide a comprehensive overview of the innovative solutions developed at Oxford Instruments for 2D material deposition and device fabrication. It will mainly focus on the low damage plasma atomic layer deposition (ALD) of high-k dielectrics on 2D materials, using the Oxford Instruments ALD system (Figure 1).

References

[1] M. Lemme et al., Nat Commun 13, 1392 (2022)

[2] Y. Illarionov et al., Nat Commun 11, 3385 (2020)

Figures

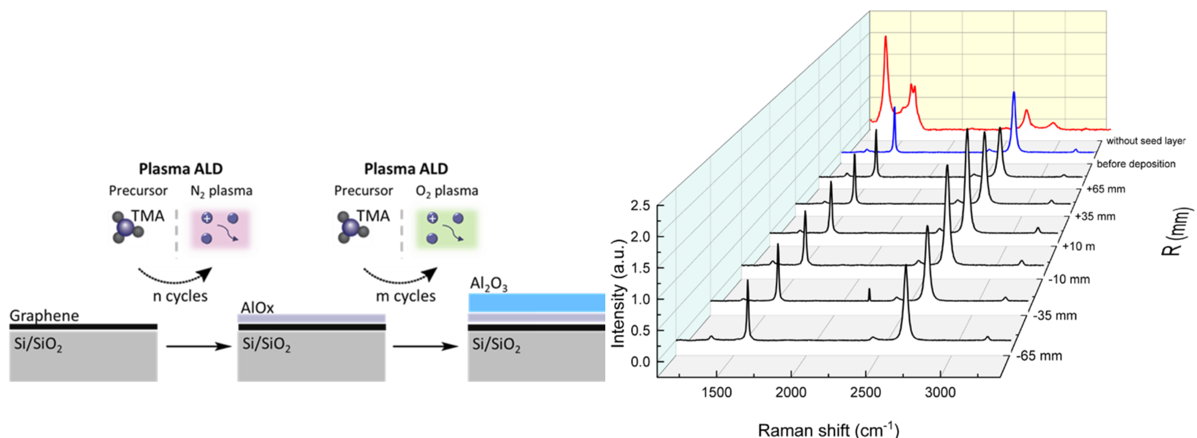

Figure 1: In the shown example, low damage plasma ALD of an Al-based seed layer is used to protect the graphene layer against plasma ALD of aluminium oxide (Al_2O_3). The low damage plasma conditions prevent damage to the graphene while providing sufficient protection for the graphene against Al_2O_3 plasma ALD. (a) Process scheme of Al-based seed layer deposition and Al_2O^3 plasma ALD. (b) Raman spectra across the wafer radius (R) for $Gr/SiO_2/Si$ wafers before (blue) and after Al_2O_3 deposition without (red) and with (black) AlOx seed-layer.