# Influence of substrate on the Atomic Layer Deposition of $Al_2O_3$ onto Graphene

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The deposition of thin dielectric layers on graphene (Gr) is a crucial aspect in order to fully exploit the potential of this material in microelectronics. Atomic layer deposition (ALD) is the most promising method to obtain uniform high-k dielectrics films with atomic scale thickness control. On the other hand, the chemically inert surface of Gr typically hinders the ALD nucleation, and pre-functionalization processes or seeding-layers have been investigated to promote the ALD deposition. Because of the wetting "transparency" of monolayer Gr [1], the underlying substrate can play an important role in the ALD growth process. In this contest, a greatly improved $Al_2O_3$ nucleation has been reported for CVD Gr residing on copper with respect to Gr transferred to $SiO_2$ [2]. Therefore, clarify the impact of the substrate nature under Gr on the ALD growth is extremely important for practical applications.

In this work, we studied morphological and electrical features of $Al_2O_3$ films deposited by thermal ALD [3] on Gr, grown and transferred on different substrates of interest for electronics. In particular, we considered epitaxial Gr grown by thermal decomposition of SiC, and CVD grown Gr on copper foils. In the case of CVD Gr, ALD deposition was performed directly on Gr residing on Cu or after Gr transfer onto different substrates (including $SiO_2$, $Al_2O_3$, SiC). Nanoscale resolution scanning probe techniques (AFM, conductive AFM) were employed to evaluate the morphology (surface coverage, grain size, roughness) and local electrical properties (leakage current, breakdown field) of $Al_2O_3$. Raman spectroscopy analyses allowed to investigate the impact of the ALD deposition on the defectivity and doping of Gr. Finally, top-gated field effect transistors were fabricated on Gr residing on the different substrates, in order to evaluate the dielectric properties of the $Al_2O_3$ gate insulator, as well as the transport properties (carrier mobility and doping density) of the Gr channel.

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