

## How to Protect Graphene inside Nanostructure, if we Use Chemical Deposition Techniques for Building Nanodevices!

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### Abstract

**Statement of the Problem:** In the Laboratory of Thin Film Technology, Institute of Physics, University of Tartu, nanostructures containing graphene are synthesized and analysed, keeping in mind their potential applications in nanoelectronics, nanosensors, electrodes for energy storage and harvesting devices. Commonly, in the Laboratory, samples are prepared where the graphene is transferred, prior to the deposition of metal oxide overlayers, to the Si/SiO<sub>2</sub> substrate. Thin layers of metal oxides, such as Al<sub>2</sub>O<sub>3</sub>, can then be grown by atomic layer deposition (ALD) on transferred graphene. According to the micro-Raman analysis carried out after the ALD of metal oxide, the G and 2D bands of graphene become slightly broadened but the overall structural quality just moderately suffered, as recognized after rather low significance of defect-related D-band. Our work has highlighted the correlation between the results of nanoindentation, electrical performance, and appearance of structural defects in graphene. **Methodology:** Graphene was grown on commercial 25 µm thick polycrystalline copper foils in an in-house built chemical vapour deposition (CVD) reactor. The foil was annealed, prior to the graphene deposition, at 1000 °C in Ar/H<sub>2</sub> flow for 60 min, and then additionally exposed to the mixture of 10% CH<sub>4</sub> (99.999%, Linde Gas) in Ar at 1000°C for 120 min. Then, the foil was cooled down in an Ar flow. Graphene was transferred onto 300 nm thick Si/SiO<sub>2</sub> substrate by using a wet chemical transferring process described in a publication by T.Kahro et al. The thin metal oxide films was deposited in a commercial PicosunTM R-200 Advanced ALD system. **Findings, Conclusion & Significance:** Large-area CVD-graphene the best way to prepare good quality graphene, being coated with thin film made by atomic layer deposition, which is widely used for preparing metal oxides for nanoelectronics devices, would be suitable for flexible electronics and components of nanodevices.

### Recent Publications

1. Kahro T, Tarre A, Kaambre T, Piirsoo HM, Kozlova J, et al. (2021) Hafnium Oxide/Graphene/Hafnium Oxide-Stacked Nanostructures as Resistive Switching Media. *CS Appl Nano Mater* 4: 5152-5163.
2. Kahro T, Castán H, Dueñas S, Merisalu J, Kozlova J, et al. (2020) Structure and behavior of ZrO<sub>2</sub>-graphene-ZrO<sub>2</sub> stacks. *J Vac Sci Technol* 38: 063411.
3. Kodu M, Berholts A, Kahro T, Eriksson J, Yakimova R, et al. (2019) Graphene-Based Ammonia Sensors Functionalised with Sub-Monolayer V<sub>2</sub>O<sub>5</sub>: A Comparative Study of Chemical Vapour Deposited and Epitaxial Graphene. *Sensors* 19: 951.

4. Tamm, Kozlova J, Aarik L, Aidla A, Lu J, et al. (2013) Atomic layer deposition of ZrO<sub>2</sub> for graphene-based multilayer structures: In situ and ex situ characterization of growth process.

### Biography

Aile Tamm received the Degree of Applied Physics from the University of Tartu, Estonia, in 2010. She is currently an Associate Professor in the Institute of Physics at University of Tartu, Estonia. At the same time, she is working as head of the Thin Film and Technology Laboratory at the same institute. Her research interests are thin film deposition and characterization technics for different type of materials and devices.

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