

Surface-enhanced Raman scattering in graphene deposited on $\text{Al}_x\text{Ga}_{1-x}\text{N}/\text{GaN}$ axial heterostructure nanowires

Jakub Kierdaszuk¹, Mateusz Tokarczyk¹, Krzysztof M. Czajkowski¹, Aleksandra Krajewska^{2,3}, Zbigniew R. Zytkiewicz⁴, Grzegorz Kowalski¹, Tomasz J. Antosiewicz¹, Maria Kamińska¹, Andrzej Wyszomolek¹, Aneta Drabińska¹

¹ Faculty of Physics, University of Warsaw, Pasteura 5, Warsaw, Poland

² Institute of Electronic Materials Technology, Wólczyńska 133, Warsaw, Poland

³ Institute of Optoelectronics, Military University of Technology, Kaliskiego 2, Warsaw, Poland

⁴ Institute of Physics, Polish Academy of Sciences, Lotników 32/46, Warsaw, Poland

GaN nanowires (NWs) with equal heights were reported as an efficient platform for surface-enhanced Raman scattering in graphene [1]. The presence of local nanogating of graphene deposited on GaN NWs suggested the electromagnetic mechanism of the effect. In order to investigate the role of electric field induced in NWs on Raman spectra intensity, graphene transferred onto GaN NWs with 100 nm $\text{Al}_x\text{Ga}_{1-x}\text{N}$ caps with x varying between 0 and 1 was studied in this work. Recently it was shown that NW structure reduces free carrier screening effect [2], therefore larger aluminium content should increase the electric field induced in NWs. In order to confirm this effect in our case, photoreflectance measurements are in progress now. Scanning electron microscopy images of the samples showed low roughness of graphene transferred onto NW substrates (Fig. 1a, b). Enhancement of Raman spectra intensity in all the investigated samples was found when comparing with graphene on GaN epilayer (EPI) (Fig. 1c). However, analysis of the enhancement factor of each band intensity indicated no explicit correlation with aluminium content (Fig. 1d). On the other hand, detailed studies of Raman bands showed that aluminium content impacts carrier concentration in graphene, although plasmon energy was far from Raman spectral range, as determined by our numerical simulations. Therefore, our results suggest the chemical mechanism of the observed enhancement of graphene Raman spectra, in contrary to electromagnetic mechanism commonly observed in other systems.

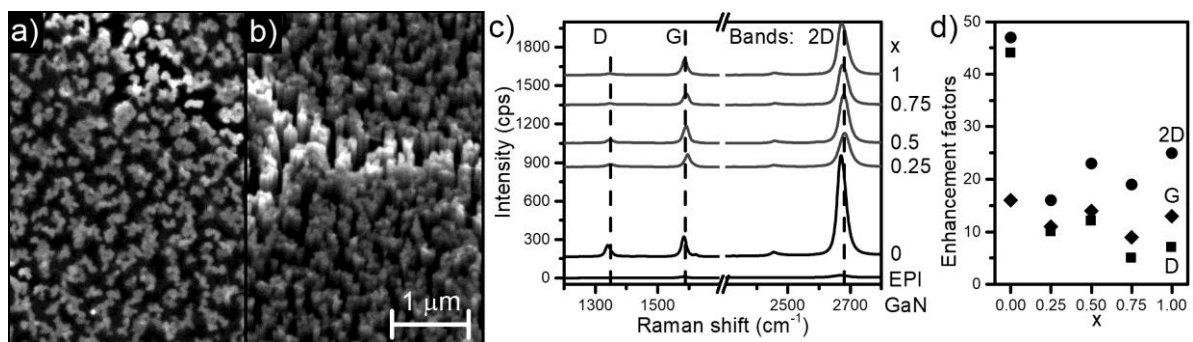


Figure 1: Scanning electron microscopy images of graphene deposited on $\text{Al}_{0.75}\text{Ga}_{0.25}\text{N}/\text{GaN}$ axial heterostructure NWs obtained at: a) 0° tilt, b) 35° tilt, c) Raman spectra of investigated samples obtained by 532 nm laser excitation, d) enhancement factors of each graphene bands.

[1] J. Kierdaszuk, et al., *Carbon* **128**, 70 (2018)

[2] N. Jamond et al., *Nanotechnology* **27**, 325403 (2016)

The research was partially supported by the Polish Ministry of Science and Higher Education for years 2015–2019 as a research grant “Diamentowy Grant No. DI2014 015744.”