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Exploring optical properties of nanostructured silver-epitaxial graphene hybrids

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Abstract

Nanoscale hybrid materials based on graphene and silver are appreciated for their possible applications in raman imaging and optical sensing due to synergetic effect originating from unique individual properties of each counterpart, namely availability of localized surface plasma resonance (LSPR) for Ag and fast conductometric response of graphene with respect to external stimulus. Here, we report a complex study of epitaxial graphene/4H-SiC interfacing with extremely thin silver nano-films (2-10 nm) grown by dc magnetron sputtering. By performing raman mapping analysis, microstructure analysis, absorbance measurements and density functional theory (DFT) calculations, we gained deep insights into (i) the nature of interaction between epitaxial graphene and Ag, (ii) mechanisms behind G and 2D raman peak intensity enhancement and (iii) the nature of defects in epitaxial graphene generated upon silver deposition. It was found that 2-5 nm silver films have uniform nano-island morphology with evident gaps between nanoparticles, which is essential condition to provide a homogeneous n-type doping of graphene and to observe surface enhanced raman scattering (SERS) effect. absorbance measurements confirmed the presence of LSPR, which was evidenced by enhanced absorbance in the visible spectrum. While 10 nm-Ag films consist of elongated nanoparticles with appearing interconnections. Thermal annealing of the nano-hybrid materials caused an enhancement of the LSPR peak intensity and a stronger SERS effect through reshaping of the Ag nanoparticles. Silver deposition also caused formation of defects, which was confirmed by the appearance of defect-related raman modes (D and D' peaks). The analysis of the mutual relationships between intensities of defect-related and characteristic modes (G and 2D peaks) enabled ascribing the generated imperfections to substitutional and/or boundary related defects. According to DFT calculations, both individual Ag adatoms and Ag clusters interact with epitaxial graphene mainly through van-der-Waals forces with small charge transfer from Ag to graphene, therefore enabling formation of Ag films weakly bonded to the substrate.

Biography

Rositsa Yakimova is professor emerita at linkoping university, sweden. She has a long-term experience in growth of SiC, AlN and graphene on SiC and she is an internationally recognized expert in the field of nanotechnology. R.Y. pioneered growth method of large area homogeneous graphene on SiC by using high temperature Ar pressure assisted sublimation process [patent protected]. Her scientific skills have resulted in many publications and innovations on the topic, including in nature materials, nature communications, nature astronomy, nature nanotechnology, etc. She has more than 500 publications in high impact factor journals, more than 8000 citations and H index 45. She is the main co-founder of graphensic AB, the first company in Europe, producing epitaxial graphene and devices using quantum hall effect.

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