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Enhanced Properties of Plasma-Induced Two-Dimensional Ga_2O_3/GaS Heterostructures on Liquid Alloy Substrate

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Abstract : Ultra-low-level incorporation of trace impurities and dopants into two-dimensional (2D) semiconductors is a challenging step towards the development of functional electronic instruments based on 2D materials. Herein, the incorporation of sulphur atoms into 2D Ga2O3 surface oxide film of eutectic gallium-indium alloy (EGaIn) is achieved through plasma-enhanced metal-catalyst dissociation of H2S gas on EGaIn substrate. This process led to the growth of GaS crystalline nanodomains inside amorphous 2D Ga2O3 sublayer films. Consequently, 2D lateral heterophase was developed between the amorphous Ga2O3 and crystalline GaS nanodomains. The materials characterization revealed the alteration of photoluminescence (PL) characteristics and change of valence band maximum (VBM) of functionalized 2D films. The comprehensive studies by conductive atomic force microscopy (c-AFM) showed considerable enhancement of conductivity of 2D Ga2O3/GaS materials (300 times improvement) compared with that of 2D Ga2O3 film. This technique has a great potential for the fabrication of 2D metal oxide devices with tuneable electronic characteristics similar to nano junction memristors and transistors.

Keywords : 2D semiconductors, Ga_2O_3, GaS, plasma-induced functionalization
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