Ultrathin Membranes and 3D Nanoarchitectures of Hollow Tetrapodal Structures Based on GaN and β-Ga_2O_3 for Multifunctional Application

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Abstract

We report on development of large-sized ultrathin GaN single crystalline membranes and of 3D nanoarchitectures based on GaN hollow microtetrapods with nanoscopic thin walls. It is shown that memristive networks consisting of GaN ultrathin membranes exhibit learning mechanisms such as habituation and dishabituation followed by storage of the response to a certain electrical stimulus, while the 3D nanoarchitecture based on GaN hollow microtetrapods (called aero-GaN) represents the first artificial material exhibiting dual hydrophobic-hydrophilic behaviour (see https://physicsworld.com/a/hydrophobic-or-hydrophilic-aero-gallium-nitride-is-both/). The GaN hollow microtetrapods are shown to self-organize when interacting with water, forming self-healing waterproof rafts and self-propelled liquid marbles promising for microfluidic applications. Heat treatment allows one to reach effective oxidation of GaN and thus to fabricate nanocrystalline ultrathin β-Ga_2O_3 membranes and 3D nanoarchitectures based on Ga_2O_3 hollow microtetrapods (called aero-Ga_2O_3). The aero-GaN exhibits shielding capabilities against electromagnetic radiation in both GHz and THz regions, while aero-Ga_2O_3 shows high transparency at GHz and THz frequencies. The support from the European Commission under Grant #810652 "NanoMedTwin" is acknowledged.