Graphene-on-Silicon-Carbide Platform for High-temperature Magnetic Diagnostics in Modern Fusion Reactors

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As the EUROfusion consortium communicates its transition from operating the science-driven, lab-based International Thermonuclear Experimental Reactor (ITER) to the industry-driven DEMO-class reactors, so evolve requirements for the liability, neutron radiation resistance, accuracy, and operability of high-temperature magnetic diagnostics systems for the control of plasma.

Łukasiewicz - IMiF has introduced a new graphene brand to answer these challenges [1]. GET®, or Graphene Epitaxy Technologies, offers an innovative graphene-based sensory platform for magnetic field detection [2-5].

The platform takes advantage of transfer-free, p-type, in-situ hydrogen-intercalated, quasi-free-standing graphene epitaxially grown on semi-insulating SiC using the Chemical Vapor Deposition method [6-9]. It is protected against environmental conditions by amorphous, atomic-layer-deposited, aluminum oxide passivation, synthesized from trimethylaluminum and deionized water at 770 K [10-11]. The sensors come in two variants. The one on semi-insulating, vanadium-compensated, on-axis 6H-SiC(0001) offers current-mode sensitivity of 140 V/AT up to 573 K, the other on semi-insulating, high-purity, on-axis 4H-SiC(0001) offers 80 V/AT but up to 770 K.

The 4H-SiC device performance is further boosted by pre-epitaxial ion implantation that reconstructs the SiC defect structure and eliminates deep electron traps related to silicon vacancies occupying the h and k sites of the 4H-SiC lattice. The modification suppresses the thermal build-up of a detrimental electron channel and improves the thermal stability of the sensor [12]. The platform is greatly resistant to fast-neutron radiation of a fluence of 6.6×10^{17} cm^{-2} and possesses a self-healing property [13].

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