U.S. Department of Energy

High Hydrogen content Epitaxial Graphene Hydride on SiC & High Cross-Section Cladding Coatings for Fast Neutron Detection

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Program: Mission Supporting Fuel Cycle R&D

ABSTRACT

Project Summary- Exploiting the SiC/EG-Hydride Materials System

We propose to exploit recent breakthroughs at the PI's lab on the electrochemistry of epitaxial grapheme (EG) formed **on commercial SiC wafers**, a transformative nanomaterial system with superior radiation detection and durability properties (See Table 1 below) to ***develop a new paradigm in detection for fast neutrons****, a* by-product of fission reactors. There are currently few effective detection/monitoring schemes, especially solid-state ones at present. This is essential for monitoring and control of future fuel cycles to make them more efficient and reliable. By exploiting these novel materials, as well as innovative hybrid SiC/EG/Cladding device architectures conceived by the team, will develop low-cost, high performance solutions to fast-neutron detection. To achieve this, we propose to:

1. Electrochemically synthesize **diamond-like EG-Hydride** by reacting with hydrogen in solution. Hydrogen content will be tuned using current level. Such precision can only be attained using electrochemistry. **The PI pioneered this technique and demonstrated its viability. We will also investigate graphene hydride on nanostructured nanoporous SiC to increase surface area and neutron sensitivity**.
2. Investigate the viability of using EG-Hydride's high hydrogen storage capacity ~7.7wt%[Ratio of H/C weight], as an ideal material for the detection of fast neutrons by proton recoil, one of the few possibilities available. **The secondary protons will be detected in the SiC backbone.**
3. Investigate the use of **high neutron absorption cross-section cladding layers**, such as Gadolinium, Samarium and Cadmium, as coatings on EG-Hydride to improve the fast neutron sensitivity of EGHydride. **The daughter species will be detected in the SiC substrate**.
4. Develop novel hybrid SiC/EG-Hydride/Cladding device architectures to enable practical, solid-state fast neutron detectors. This will be achieved **rationally through simulation and modeling**. In particular, we will explore **3-terminal** architectures that have not been studied extensively to date.
5. **Encourage diversity in nuclear sciences** through outreach to Richland County high schools and South Carolina State University (large proportion African American) to bridge the demographic gap between the County (45% African American) and USC (16% African American). We will work with Dr. K. Lewis at SC State to achieve this.
6. Facilitate the transfer of knowledge and technology of national interest by fostering a **sustainable collaboration with Savannah River National Laboratory**. In other words, the ultimate technical goals of these objectives will be to develop and implement a superior low-cost, large area (potentially >32in), easily deployable, close proximity, harsh environment innovative sensor needed for next generation fuel cycle monitoring.