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Glassy Polymer Carbon and Silicon Carbide to be used in the TRISO fuel

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Abstract
In this study the authors investigate the methods of preparing Glassy Polymeric Carbon (GPC) and Silicon Carbide (SiC), elemental and microstructure characterization of GPC and SiC as well as the defects that appear in the structures of GPC and SiC and their contribution to the net changes in physical properties and structures before and after different fluence irradiation with 1 MeV protons, 5 MeV Ag and 5 MeV Au bombardment.

The TRISO fuel that is planned to be used in some of the Generation IV nuclear reactor designs consists of a fuel kernel of UO_x coated in several layers of materials with different functions. In this study we investigate the methods of preparing Glassy Polymeric Carbon (GPC) and Silicon Carbide (SiC), elemental and microstructure characterization of GPC and SiC, the defects that appear in the structures of GPC and SiC and their contribution to the net changes in physical properties and structures before and after different fluence irradiation with 1 MeV protons, 5 MeV Ag and 5 MeV Au bombardment. We chose protons to simulate the effects of neutrons. During the nuclear fission of ^{235}U, the fission fragment mass distribution has two maxima around mass 98 and 137 that would best fit Rb and Cs, respectively. However, both ions are hard to produce from our SNICS source at the accelerator, therefore we chose Ag (107 amu) and Au (197 amu) as best replacements. In this study, scanning electron microscopy (SEM), transmission electron spectroscopy (TEM), nano-indentation, X-ray photoelectron spectroscopy (XPS) and Raman Spectroscopy will be used for characterization.

This work will help to understand the fundamentals mechanisms and yield of defect creation in sp^2-bonded carbons by particle radiation. The type and concentration of such defects have deep implications in the physical properties of carbon-based materials for various applications from carbon-based quantum electronics to structural components for aerospace applications. Here, in particular, we are focusing on two types of carbons, glassy polymeric and pyrolytic, for a specific application in an extreme radiation environment, the core of nuclear reactor.

Another purpose of this work is to understand the changes in fundamental properties (chemical and mechanical stability) of SiC ceramics after exposure to temperatures up to 2500ºC. This study will help to determine its eligibility for future irradiation testing for a specific application in an extreme radiation environment in the nuclear reactor. It will also help to determine if SiC will be a good choice as a diffusion barrier in the fuel cells of the TRISO fuel that will be used in the next generation of nuclear reactors.