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STUDY OF THE IMMOBOLISATION OF PALLADIUM BY SILICON AND ZIRCONIUM IN GRAPHITE.

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Current high temperature gas reactor designs use TRISO-coated particles as fuel. The TRISO-coated particle consists of a fuel kernel and coating layers of porous pyrolitic carbon (PyC), inner high-density PyC, silicon carbide (SiC) and outer high-density PyC. The SiC layer serves as the main barrier to fission product release1. However it has been reported that the radioactive fission product Ag110m can escape from intact TRISO particles2. It was also found that the fission product palladium (Pd) significantly enhances the migration of silver along grain boundaries in SiC3,4.

This paper investigates the feasibility of using Pd traps such as Si and ZrC in the inner PyC layer of TRISO particles to capture the Pd and prevents it from migrating to the SiC layer by forming immobile silicide compounds in the case of Si. It is proposed that without Pd in the SiC, the migration rate of Ag in SiC will be significantly reduced.

Graphite discs (used to simulate PyC) were implanted with 137,5 keV Si and 190 keV Zr ions to doses of 8,27 x1015 Si ions cm-2 and 5x1015 Zr ion cm-2. Pieces of implanted graphite discs, with a layer of Pd powder on the implanted surface, were subsequently annealed for 20 min. at temperatures of 600 and 900 ℃. TEM samples were cut using a focused Ion Beam (FIB) and analysed using a JEOL 2100 TEM.

Fig. 1 (a) is a cross-sectional HAADF STEM micrograph of Si implanted graphite annealed in contact with Pd powder at 600 ℃ for 20 min. The bright particles are the Pd on the Si implanted graphite as indicated in the figure. Fig. 1 (b) is a HAADF STEM micrograph showing the location of the EDS line scan across a Pd particle and into the Si implanted graphite. The corresponding EDS line scans for Pd, C and Si are shown in (c) together with the location of the implanted graphite surface. The similarity of the Pd and Si line scans indicate that at 600 ℃, the Si rapidly diffused out of the graphite and into the Pd particles. The same result was obtained after annealing at 900 ℃ for 20 min. which is indicative of the high chemical reactivity of Pd and Si to form a silicide3. The current study revealed that the palladium silicide formed will most likely be immobile in graphite (and PyC) at temperatures up to 900 ℃.

The EDS results of the Zr implanted graphite annealed in contact with Pd at 600 and 900 ℃ indicated that Zr did migrate into Pd but the reaction was less pronounced than that found for Si. The incorporation of Si into the inner PyC layer of a TRISO particle during manufacturing would be easier and more effective as Pd trap than ZrC.

Apply to be considered for a student ; award (Yes / No)?

yes

Level for award;(Hons, MSc, PhD, N/A)?

MSc Physics

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