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## TMSR materials development: Carbide dispersed strengthening nickel based alloys

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The development of high-temperature irradiation-resistant nickel-based alloys has been receiving much attention due to their potential applications in molten salt reactors (MSRs). Silicon carbide nanoparticle-reinforced nickel-based composites (Ni-SiC<sub>NP</sub>), with milling time ranged from 8 to 48h, were prepared using mechanical alloying and spark plasma sintering. In addition, unreinforced pure nickel samples were also prepared for comparative purposes. The microstructure of the Ni-SiC<sub>NP</sub> composites was characterized by TEM and their mechanical properties were investigated by tensile measurements. The TEM results showed well-dispersed SiC<sub>NP</sub> particles, either within the matrix, between twins or along grain boundaries (GB), as well as the presence of stacking faults and twin structures, characteristics of materials with low stacking fault energy. The tensile test results indicated that the addition of SiC<sub>NP</sub> can effectively strengthen the nickel. Furthermore, the helium diffusion behavior of such composites and pure nickel under 3 MeV helium ion irradiation at 600°C with ion fluence up to 3×10<sup>20</sup> ions/m<sup>2</sup> has also been studied. The TEM results indicated that the presence of dispersed SiC<sub>NP</sub> in nickel can inhibit the growth of helium bubbles, thereby mitigate the helium embrittlement and swelling of nickel-based alloys. The theoretical calculation results using the density functional theory (DFT) showed that the helium atoms prefer to diffuse to the interface between SiC<sub>NP</sub> and nickel matrix, and thus avoid the grain boundary segregation and also the growth of helium bubbles. This study confirmed the feasibility of dispersing carbides in nickel-based alloys to improve the irradiation-resistant performance of materials.

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## Insulators turning into conductors after adding dopants

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Polymetaboluidine (PMT) and Polyaniline (PANI) prepared by McDiarmid method, after doping with different dopants (salts of transition metals like copper, Brown-red complex of copper with 2,9-dimethylphenanthroline [Cu (DMPhen)<sub>2</sub>] ClO<sub>4</sub>.) become conductor, which are otherwise insulators. The brown-red complex was dissolved in 1:1 ratio of water and Tetra Hydro Furan (THF). PMT and PANI were separately dissolved in THF and doped with the complex in different ratio of 2%, 4% and 6%. Structural characterization of PMT and PANI prepared after doping of with different dopants have been studied at different concentration of dopant. FTIR, Scanning Electron Microscopy (SEM) and X-ray Diffraction were used for structural characterization of the prepared doped PMT and PANI. These types of measurements of doped polymetaboluidine and polyaniline systems will be helpful for the development of conducting polymeric materials. DC conductivity also proves the formation of conducting materials after doping.

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