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EMAMs - Additive Manufacturing of Molecular-Level-Engineered SiCN Ceramic Modified with Carbon Nanofibers/Transition Metal Carbides towards Next-Generation Structural Electromagnetic Metamaterials

Ceramic-based high-temperature structural electromagnetic absorption materials (EMAMs) is playing an increasingly important role in combating the EM pollution. However, ceramic-based EMAMs always suffer from poor mechanical strength due to the intrinsic high brittleness, and unsatisfactory EM performance limited by the material characteristic as well as the monotonous loss mechanism of absorbents. In this project, advanced SiCN matrix modified with one dimensional (1D) carbon nanofibers/2D transition metal carbides (e.g., TiC, VC and Mo₂C) (CNFs/TMCs-SiCN) ceramic-based structural EM metamaterials will be innovatively developed by combining molecular-level-engineered polymer derived ceramic (PDC) and Additive Manufacturing (AM) techniques. Novel 2D TiC, VC and Mo₂C nano-absorbents/reinforcements will be developed via a precursor-derived method. Outstanding EM performance is expected to be realized by the establishment of multi-loss mechanisms (i.e., interface, defect-induced and dipole polarization loss, and conductive loss) via nano/microstructure engineering of CNFs/TMC absorbents, and realization of novel meta-structures using AM. Improved mechanical strength will be achieved by strengthening of the SiCN matrix by CNFs/TMCs. The main idea of the present proposal is to merge material type and nano/microstructure innovation of absorbents/reinforcements as well as meta-structure innovation of materials to innovatively develop the CNFs/TMCs-SiCN structural EM metamaterials as the next generation hightemperature structural EMAMs. The general relationship between (nano- and micro-)structure, macro-structure (by design) and loss mechanisms, EM and mechanical properties will be revealed. This project will pave new avenue for the development of next generation EMAMs.

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