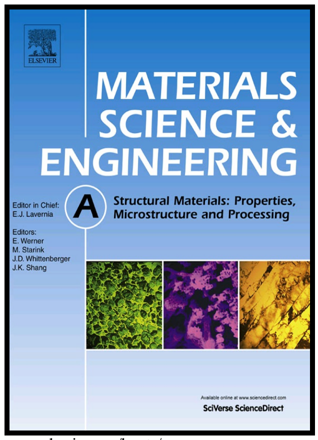

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Study on the thermal and mechanical properties of novel neutron shielding composite laminates at elevated temperature

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Abstract: Neutron shielding fibre metal laminates (NSFMLs) containing 10-50wt% of boron carbide (B_4C) powder were fabricated using hot molding process, and the effects of experimental temperature on the thermal and mechanical properties of composite laminates were investigated in this work. Thermal stability of composite laminates was conducted with thermo-gravimetric analysis (TGA) and differential scanning calorimetry (DSC), and their mechanical properties were also measured. The testing results indicated that good interfacial adhesion between different layers, uniform distribution of B_4C particles and carbon fibres tightly surrounded by polyimide (PI) resin were crucial to the mechanical properties of composite laminates. TGA-DSC results illustrated the scarcely mass loss of composite laminates below 300 °C, yet began to decompose when it exceeded over 390 °C. Moreover, tensile strength of the NSFMLs degraded with the increasing of experimental temperature and the volume fraction of B_4C powder. Double bear shear (DBS) testing results showed that the NSFMLs with 30wt% of B_4C powder had the maximum interlaminar shear value, while the primary delamination zone occurred at the interface between two layered carbon fibre reinforced prepregs (CFRPs). The composite laminates still maintained the good interlaminar shear strength even at 300 °C.

Keywords: Neutron shielding fibre metal laminates (NSFMLs); Thermal properties; Interlaminar shear (ILS) strength; Hot molding process

1. Introduction

With the increasing requirements in energy to satisfy the basic survival and development needs of human beings, energy structure of coal-fired power generation brings great challenges to the ecological environment, making people's attention paid on other clean energy resources, such as nuclear energy. The main reason lies in that nuclear energy is the cleanest and most cost-effective power resources presently, and more than 15% of the world's electricity comes from nuclear power plants (NPPs) [1-3]. Although nuclear fuel could not yield carbon dioxide or other harmful greenhouse gas emissions, it creates its own waste in the form of highly radioactive spent nuclear fuel enriched in the fissile ^{235}U [4]. All types of radioactive wastes need to be carefully managed so as to keep the public safe, protect the environment and ensure the security from accidental or deliberate intrusion [5-7]. Normally, there are two primary byproducts, including the spent nuclear fuel (SNF) from nuclear reactors and high-level waste from the reprocessing of spent nuclear fuel, and how to cope with such byproducts is the first problem facing the scientists around the world [8]. Usually, the measurements taken are concentrated on the management, conservation and direct reusage of SNF, to ensure the safety management of the NPPs [9].

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