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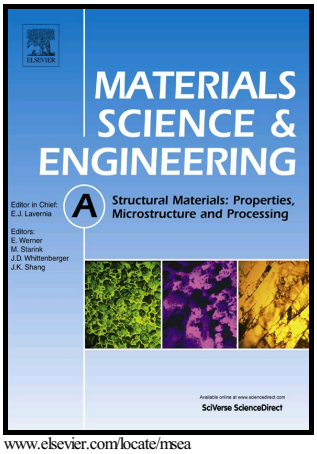

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High-temperature behavior and degradation mechanism of Si_3N_4 fibers annealed in air and N_2 atmosphere

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Abstract: Continuous silicon nitride (Si_3N_4) fibers are considered as promising high-temperature wave-transparent fibers, the high-temperature performance and composition changes of which need to be investigated. The Si_3N_4 fibers were heat-treated at elevated temperatures for different duration times in air and N_2 atmosphere, respectively. The compositions, microstructures and mechanical properties were investigated by XRD, XPS, SEM, tensile strength analysis. The results show that the heat-treatment temperature, exposure time and atmosphere all can influence the performance of the fibers. And the decrease in strength of the Si_3N_4 fibers annealed in N_2 is due to the thermal decomposition of Si_xN_yO and grain growth of Si_3N_4, while the degradation of the fibers annealed in air mainly owing to the oxidation reactions.

Keywords: Si_3N_4 fibers; heat-treatment; duration time; degradation mechanism

1. Introduction

Ceramic matrix composites (CMCs) are being developed for a variety of high-temperature applications[1], such as antenna window, radome, wing edge, nozzle and combustion chamber of high-speed vehicles. The high-temperature properties of CMCs are largely dependent on the reinforcements[2]. Nowadays, the advanced reinforcement fibers which can be applied in high-temperature wave-transparent applications mainly including the silica fibers, boron nitride fibers, silicon nitride fibers and the Si-B-O-N fibers[3,4]. Silica (SiO_2) fibers can only be used under the temperature of 1000°C for long duration due to the nucleation and crystallization of α-cristobalite. Boron nitride (BN) fibers remain to be improved for moisture resistance[5]. Si-B-O-N fibers are still being studied at the laboratory level[6]. Compared with above fibers, continuous silicon nitride (Si_3N_4) fibers are considered as one of the most suitable reinforced fibers for high-temperature wave-transparent ceramic matrix composites (CMCs) applied in radome materials[7,8], due to their ascendant properties, including excellent mechanical properties, high oxidation resistance, superior electrical insulting property under high-temperatures and low dielectric constant[9-11].

Recently more and more studies of silicon nitride fibers have been reported for optimizing preparation and