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FIBROUS CERAMIC TILES FOR ULTRAHIGH TEMPERATURE THERMAL INSULATION

Abstract

Ultrahigh temperature ceramics are potential materials for use in extreme environments such as scramjet engine components, leading edges and thermal protection systems for hypersonic vehicles. The working temperature of current silica-based fibrous ceramic insulation tiles is less than 1500 degree C, which cannot meet the requirements of novel aerospace vehicles. In this work, alumina-based fibrous ceramic insulation tiles were developed and investigated. The tiles were formed by mixing the slurry of alumina fibers and a binder, vacuum-molding and firing the dried billet. The materials' microstructure, thermophysical and mechanical properties were characterized and measured. It was found that the type of binder, the amount of binder and the sintering temperature were key processing factors; the thermal conductivity at room temperature and mechanical properties varied approximately linearly with density. The insulation materials had a linear shrinkage of 1% after heating at 1500 degree C for 1h. Because of the bonding between the fibers, the tiles possessed both relatively low thermal conductivities and strong mechanical properties. The tiles had a low density in the range of 0.3-0.6 g/cm3, thermal conductivity of 0.06-0.10W/(m·K), and compressive strength of 0.7-1.8MPa. In addition, in the back temperature test, a typical alumina-based tile showed a similar cold-surface temperature curve (850 degree C) compared with a silica-based tile when heated at 1200 degree C for 30min; and the tile's cold-surface temperature was 1070 degree C when heated at 1400 degree C for 30min. Furthermore, the experimental results of thermal conductivities up to 1200 degree C had similar trend with the calculated values. Finally, different opacifiers were added to the tiles to improve the thermal insulation performance at higher temperatures. Therefore, the fabricated alumina-based tile is a promising candidate for ultrahigh temperature insulation applications.