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PROCEEDINGS

Thermal Insulating and Fire Retardant Si_3N_4 Nanowires Membranes Resistant to High-Temperatures up to 1300 °C

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ABSTRACT

Superior thermal insulating and fire-retardant ceramic membranes are urgently demanded in the aerospace, construction and chemical engineering industries. However, the generic characteristics of ceramic membranes, such as brittleness, structural collapse and crystallization-induced pulverization behavior, present a great plague to their practical applications. Herein, we report a highly flexible, mechanically stable, fire retardant and high-temperature-resistant ceramic membrane based on the interlocked Si_3N_4 nanowires formed by the precursor pyrolysis method. The Si3N4 nanowires membrane (SNM) has excellent high temperature resistance under alcohol lamp and butane spray lance. The thermal insulation with a thermal conductivity as low as 0.056 W/(m·K) can be attributed to the high porosity of SNM, which makes it a desirable candidate for heat insulators under harsh conditions. More importantly, SNM exhibits thermal stability and robust mechanical properties in the range of 25 °C to 1300 °C. The high-temperature resistance of SNM up to 1300 °C is achieved by the four stages: Si_3N_4 nanowires, Si_3N_4@SiO_2 nanowires, SiO_2 nanowires and bead-like SiO_2 nanowires. After heat-treated at 1300 °C, the macroscopic size of SNM does not change significantly, and the interlocked structure is still maintained. Furthermore, SNM still maintains excellent mechanical properties, with a tensile strength as high as 0.26 MPa. This work provides a facile method for fabricating excellent thermal insulation and flame-retardant ceramic membranes, showing prospective application prospects in the era of thermal insulation materials.

KEYWORDS

Silicon nitride nanowires; thermal insulation; fire-resistance; high-temperature resistance

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