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溶胶共凝法制备准连续密度梯度SiO₂气凝胶

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Fabrication of Graded Density SiO₂ Aerogel via Sol-Co-Gelation Techniques

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摘要

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摘要 针对气凝胶在航空航天领域的应用需求,为了进一步拓展单一密度气凝胶的应用范围,对密度梯度SiO₂气凝胶的制备进行了研究。采用自建密度梯度制备成型装置,以正硅酸乙酯为有机硅源,经溶胶共凝工艺,结合CO₂超临界干燥技术,获得密度范围在60~160 mg/cm³的准连续密度梯度SiO₂气凝胶。采用光学显微镜、扫描电子显微镜、X射线相衬成像等手段对制备获得的SiO₂气凝胶进行测试表征。通过与逐层凝胶法制备的密度渐变SiO₂气凝胶进行对比发现,溶胶共凝工艺消除了层间界面处所产生的致密层和密度突变,有利于相邻两层间的互扩散,使密度变化更趋于连续。采用该法制备的密度梯度气凝胶拓展了常规气凝胶的应用范围,在声阻抗匹配和空间粒子捕获等领域有潜在的应用前景。

关键词: 溶胶共凝 准连续气凝胶 密度梯度 逐层凝胶 互扩散

Abstract: For the application requirement in aerospace and further expanding the application field of aerogel, the fabrication of gradient density aerogel SiO₂ has been researched in this paper. By a self-built device, a continuously graded silica aerogel is fabricated via special sol-co-gelation techniques, with tetraethoxysilane (TEOS) as the organic precursor and by a supercritical drying process. Its density ranges from 60 mg/cm³ to 160 mg/cm³. Scan electron microscope, X-ray phase contrast method and optical microscopy are used to characterize the graded density silica aerogel prepared. Compared with the graded density silica aerogel produced by layer-by-layer gelation techniques, the sol-co-gelation techniques smooth out density mutation and increase the interdiffusion between adjacent layers, which makes density change tend to be more continuous. The gradient density aerogel fabricated by such a method expands greatly the application of conditional aerogel. It can potentially be used in many fields such as acoustic impedance matching and interstellar particles collection.

Keywords: sol-co-gelation continuous aerogel graded density layer-by-layer gelation interdiffusion

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