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空间探索用梯度密度气凝胶的合成与应用进展

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Progress in Preparation and Application of Density-graded Aerogels for Space Exploration

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摘要 参考文献 相关文章

摘要 气凝胶是空间探索领域的关键功能材料。系统介绍了单一密度气凝胶和梯度密度气凝胶材料的分类、合成方法、复合工艺、特殊性能及其在空间探索领域的应用。其中,梯度密度气凝胶材料的合成是国际上的技术难点,笔者结合自身研究将其复合方式分为早期方法、分层粘贴法、逐层凝胶法和梯度溶胶共凝胶法,揭示了梯度气凝胶应遵循由单位深度的低差异到高差异、由分层梯度到连续梯度(界面消除)、由低控制精度向高控制精度、由均匀梯度向任意设计梯度的发展规律;并基于梯度密度气凝胶在高速粒子捕获、高效保温隔热与切伦科夫探测等方面的特殊应用,对梯度气凝胶成分和特性(密度、折射率和热导率等)的梯度分布提供了功能化设计。

关键词: 梯度密度 气凝胶 空间探索 功能材料 合成 应用

Abstract: Aerogel is a kind of key functional material for space exploration. In this paper, the classification, preparation methods, composite techniques, unique properties and space-exploration applications of homogenous aerogels and density-graded aerogels are systematically introduced. In particular, the composite technique of density-graded aerogels, which is regarded as a focus of international research, is classified into early method, multilayer-pasted method, layer-by-layer gelation method and gradient-sol co-gelation method. Also, the developing trends of the density-graded aerogels are summarized as the transitions from low gradient to high gradient, from graded density to gradient density, from low control accuracy to high control accuracy, and from homogeneous gradient to designed gradient, based on the previous studies of the authors. Furthermore, several functional designs on the distributions of composition and properties (density, refractive index and thermal conductivity) of the density-graded aerogels are provided, in order to meet the requirements of hyper-velocity particle capture, high-performance thermal insulation and high-resolution Cherenkov detection.

Keywords: density-graded aerogels space exploration functional materials synthesis applications

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