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## 包覆结构 $\text{CeO}_2/\text{SiO}_2$ 复合磨料的合成及其应用

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**摘要:** 以正硅酸乙酯水解所得的 $\text{SiO}_2$ 微球为内核, 采用均匀沉淀法制备具有草莓状包覆结构的 $\text{CeO}_2/\text{SiO}_2$ 复合粉体。利用X射线衍射仪、透射电子显微镜、X射线光电子能谱仪(XPS)、动态光散射仪和Zeta电位测定仪等手段, 对所制备样品的物相结构、组成、形貌和粒径大小进行表征。将所制备的包覆结构 $\text{CeO}_2/\text{SiO}_2$ 复合粉体用于硅晶片热氧化层的化学机械抛光, 用原子力显微镜(AFM)观察抛光表面的微观形貌, 测量表面粗糙度, 并测量材料去除率。结果表明: 所制备的 $\text{CeO}_2/\text{SiO}_2$ 复合颗粒呈规则球形, 平均粒径为150-200 nm,  $\text{CeO}_2$ 纳米颗粒在 $\text{SiO}_2$ 内核表面包覆均匀。 $\text{CeO}_2$ 颗粒的包覆显著地改变复合颗粒表面的电动力学行为,  $\text{CeO}_2/\text{SiO}_2$ 复合颗粒的等电点为6.2, 且明显地偏向纯 $\text{CeO}_2$ ;  $\text{CeO}_2$ 外壳与 $\text{SiO}_2$ 内核之间形成 $\text{Si}-\text{O}-\text{Ce}$ 键, 两者产生化学键结合; 抛光后的硅热氧化层表面在 $2\ \mu\text{m} \times 2\ \mu\text{m}$ 范围内粗糙度为0.281 nm, 材料去除率达到454.6 nm/min。

**关键字:**  $\text{CeO}_2/\text{SiO}_2$ 复合磨料; 包覆; 化学机械抛光

## Synthesis and application of $\text{CeO}_2$ -coated $\text{SiO}_2$ composite abrasives

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**Abstract:** The  $\text{SiO}_2$  nanoparticles prepared by the hydrolyzing tetraethylorthosilicate were directly coated with  $\text{CeO}_2$  by chemical precipitation technique. The as-prepared samples were analyzed with X-ray diffractometry(XRD), transmission electron microscope, X-ray photoelectron spectrometer, dynamic light scatter and Zeta potential analyzer. The thermal oxide film covered silicon wafer was polished by  $\text{CeO}_2$ -coated  $\text{SiO}_2$  composite abrasives, and the polishing behavior of the novel composite abrasives was characterized by atomic force microscope (AFM). The results indicate that the monodisperse, spherical  $\text{CeO}_2$ -coated  $\text{SiO}_2$  particles have a particle size of 150–200 nm and are uniformly coated by the  $\text{CeO}_2$

nanoparticles. The isoelectric point of CeO<sub>2</sub>-coated SiO<sub>2</sub> nanoparticles is about 6.2, which displays a significant shift toward pure CeO<sub>2</sub>. The shell CeO<sub>2</sub> is chemically bounded with SiO<sub>2</sub> core, and the Si—O—Ce bond forms between them. The surface roughness within 2 μm×2 μm area of thermal oxide film polished by CeO<sub>2</sub>-coated SiO<sub>2</sub> composite abrasives is 0.281 nm, and the material removal rate reaches 454.6 nm/min.

**Key words:** CeO<sub>2</sub>-coated SiO<sub>2</sub> composite abrasives; coating; chemical mechanical polishing

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