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研究论文

具有固-液转变的磁性Fe<sub>3</sub>O<sub>4</sub>纳米流体的制备、结构及性能

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**摘要:** Fe<sub>3</sub>O<sub>4</sub>纳米粒子与离子型改性剂N, N-二癸基-N-甲基-N-三甲氧基硅正丙基氯化铵进行接枝反应, 再采用反离子脂肪醇聚氧乙烯醚磺酸盐的长链阴离子交换Cl<sup>-</sup>, 在Fe<sub>3</sub>O<sub>4</sub>纳米粒子表面得到具有阴、阳离子双电层结构的表面处理层, 制备出了无溶剂Fe<sub>3</sub>O<sub>4</sub>纳米流体。分析结果表明, 表面处理层已成功地接枝在Fe<sub>3</sub>O<sub>4</sub>纳米粒子表面, 改性的Fe<sub>3</sub>O<sub>4</sub>纳米粒子呈单分散, 其损耗剪切模量G''明显大于储能剪切模量G', 并具有明显的流体行为, 室温下存放一年状态稳定, 流动性良好。

**关键词:** 无机非金属材料 磁性纳米粒子 表面改性 无溶剂纳米流体 固-液转变

Synthesis, Structure and Properties of Fe<sub>3</sub>O<sub>4</sub> Nanofluids with Liquid-like Behavior

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**Abstract:** Fe<sub>3</sub>O<sub>4</sub> nanoparticles were modified with ionic surfactant (CH<sub>3</sub>)<sub>3</sub>Si(CH<sub>2</sub>)<sub>3</sub>N<sup>+</sup>(CH<sub>3</sub>)(C<sub>10</sub>H<sub>20</sub>)<sub>2</sub>Cl<sup>-</sup>, and then the chloridion was replaced by the anion C<sub>9</sub>H<sub>19</sub>C<sub>6</sub>H<sub>4</sub>(OCH<sub>2</sub>CH<sub>2</sub>)<sub>2</sub>O(CH<sub>2</sub>)<sub>3</sub>SO<sup>-</sup>3 through an ion-exchange process. As a result, an electrical double-layer structure was formed on the surface of Fe<sub>3</sub>O<sub>4</sub> nanoparticles. The results showed that the surface layer has been successfully grafted on Fe<sub>3</sub>O<sub>4</sub> nanoparticles surface and the modified Fe<sub>3</sub>O<sub>4</sub> nanoparticles were well dispersed. The loss shear modulus G'' of Fe<sub>3</sub>O<sub>4</sub> nanofluids was significantly greater than the storage shear modulus G' at room temperature, which confirms the typical fluid-behavior. Great stability and good flowability are well maintained after standing for a year at room temperature.

**Keywords:** inorganic non-metallic materials magnetic nanoparticles surface modification solvent-free nanofluids solid-liquid transformation

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