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掺杂Ce的TiO_2纳米粒子的光致光及其光催化活性

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摘要 采用sol-gel法制备了纯的和掺杂不同量Ce的TiO_2纳米粒子，并利用XRD， TEM，BET，XPS和PL光谱对样品进行表征，主要考察焙烧温度和含量对掺杂Ce的 TiO_2纳米粒子性质以及光催化降解苯酚活性的影响，并探讨了Ce的掺杂对TiO_2相变的作用机制以及PL光谱与光催化活性的关系，结果表明，掺杂的Ce~(4+)没有进 入到TiO_2晶格中，而是以小团簇的CeO_2化学态均匀地弥散在TiO_2纳米粒子中， 这可能导致了Ce的掺杂对TiO_2的相变有很大的抑制作用；Ce的掺杂没有引起新的 光致发光现象，而适量Ce的掺杂能够降低TiO_2纳米粒子PL光谱的强度，这是因为 掺杂的Ce~(4+)易于捕获光生电子而生成Ce~(3+);600℃处理的掺杂Ce的TiO_2纳米 粒子表现出较高的光催化活性，这说明600℃是比较合适的焙烧温度，而掺杂不同 量的Ce的TiO_2样品的光催化活性顺序是：3 mol%＞4 mol%＞2 mol%＞5 mol%＞1 mol%＞0 mol%，这与它们的PL光谱强度的顺序是相反的，即PL光谱强度越低，其 光催化活性越高，这说明PL光谱与其光催化活性间有着必然的联系，这是因为掺杂 剂Ce~(4+)能够捕获光生电子，在光致发光过程中使PL光谱强度下降，而在光催化 反应过程中使有机污染物加快氧化。

关键词 二氧化钛 纳米相材料 掺杂 铈 光催化 苯酚 溶胶-凝胶法

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Photoluminescence of Ce Doped TiO_2 Nanoparticles and Their Photocatalytic Activity

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Abstract In this paper, TiO2 nanoparticles pure and doped with varying content of Ce were prepared by a sol-gel process using Ti(OC_4H_9)_4 as raw material and characterized by XRD, TEM, BET, XPS and PL spectra. We mainly investigated the effects of calcining temperature and Ce content on the properties and the photocatalytic activity for degrading phenol of the TiO2 nanoparticles. The relationships between PL spectra and photocatalytic activity as well as the mechanisms of Ce doping on TiO2 phase change were also discussed. The results show that Ce4+ did not enter into the crystal lattices of TiO2 and was uniformly dispersed into TiO2 as the form of CeO2 with small size, which possibly made Ce dopant have a great inhibition on TiO2 phase change; Ce dopant did not give rise to a new PL signal, but an appropriate content of Ce could make the intensity of PL spectra down, which was attributed to the ability of Ce + to easily capture the photoinduced electrons to form Ce3+; Ce doped TiO2 nanoparticles calcined at 600 t exhibited higher photocatalytic activity, indicating that 600 ℃ was an appropriate calcination temperature. The order of the photocatalytic activity of TiO2 samples doped with varying content of Ce is as follows: 3 mol% > 4 mol% > 2 mol% > 5 mol% > 1 mol% > 0 mol%, which is opposite to the order of their PL intensity, namely, the weaker the PL intensity, the higher the photocatalytic activity, demonstrating that there are certain relationships between PL spectra and photocatalytic activity. This could be explained by the fact that the dopant Ce4+ can readily capture the photoinduced elections, which not only makes the intensity of PL spectra down during the process of phololuniinescenoe but also improves the oxidation speed of organic pollutants during the process of pliotocatalytic reaction.

Key words TITANIUM DIOXIDE NANOPHASE MATERIALS DOPE CERIUM PHOTOCATALYSIS PHENOL SOL-GEL PROCESS

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