



The microemulsion preparation and high catalytic performance of mesoporous NiO nanorods and nanocubes for toluene combustion

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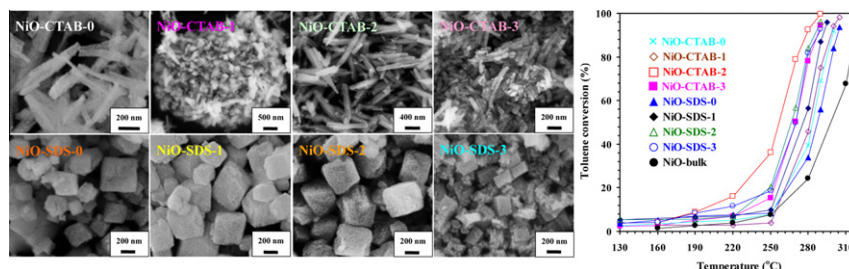
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HIGHLIGHTS

- ▶ Porous NiO nanorods and nanocubes are prepared by the microemulsion method.
- ▶ CTAB addition favors the formation of mesoporous NiO nanorods.
- ▶ SDS addition favors the formation of mesoporous NiO nanocubes.
- ▶ NiO-CTAB-2 displays the highest surface area and best low-temperature reducibility.
- ▶ Surface area, O_{ads} content, and reducibility govern catalytic activity.

GRAPHICAL ABSTRACT

Mesoporous nickel oxide nanorods and nanocubes (NiO-CTAB and NiO-SDS) are fabricated using a facile microemulsion strategy with CTAB or SDS as surfactant. It is shown that the larger surface area, higher oxygen adspecies concentration, and better low-temperature reducibility are responsible for the excellent catalytic activity of porous NiO-CTAB-2.



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ABSTRACT

Cubically crystallized mesoporous nickel oxide nanorods and nanocubes were fabricated by using a facile microemulsion strategy with cetyltrimethylammonium bromide (CTAB) or sodium dodecyl sulfate (SDS) as surfactant. Physicochemical properties of the materials were characterized by means of a number of analytical techniques, and their catalytic activities were evaluated for the combustion of toluene. It was shown that the morphology of the samples strongly depended on the nature of surfactant: when CTAB was used, the product was mesoporous NiO nanorods; when SDS was adopted, mesoporous NiO nanocubes were obtained. The NiO-CTAB-2 sample derived with a Ni^{2+} /CTAB molar ratio of 0.364 displayed the highest surface area (ca. $46 \text{ m}^2/\text{g}$) and the best low-temperature reducibility. A clear correlation of oxygen adspecies concentration or low-temperature reducibility with catalytic performance was observed. The high catalytic activity ($T_{50\%} = 256^\circ\text{C}$ and $T_{90\%} = 278^\circ\text{C}$ at $SV = 20,000 \text{ mL}/(\text{g h})$) for toluene combustion of NiO-CTAB-2 was related to its larger surface area, higher oxygen adspecies concentration, and better low-temperature reducibility.

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1. Introduction

Nanomaterials exhibit fascinating physicochemical properties, which render them to have potential applications in many fields.

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The size and morphology of a nanomaterial can greatly influence its optical, electronic, magnetic, and catalytic properties. Up to now, many advancements have been achieved on size and morphology controlled synthesis of nanomaterials. If the morphology and assembly mode of the original building units could be manipulated in a controlled manner, their secondary architectures would be tailor-made to meet the desired needs. Transition-metal oxide