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Preparation, characterization and photocatalytic degradation of methyl violet pollutant of holmium oxide nanostructures prepared through a facile precipitation method

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ABSTRACT

Holmium oxide nanostructures were prepared through a facile precipitation way applying triethylenetetramine as a novel precipitant and $Ho(NO_3)_3 \cdot 6H_2O$ as a holmium precursor. The effect of different capping agents on the size, shape and photocatalytic behavior of holmium oxide was studied. It was found that the type of capping agent has an effective role in shape, size and photocatalytic behavior control. The as-produced holmium oxide has been analyzed with applying EDX, FESEM, DR-UV–vis, TEM, XRD and FT-IR. The photocatalytic performances of as-obtained holmium oxide samples have been compared in the degradation of methyl violet pollutant under UV illumination.

1. Introduction

Holmium oxide (Ho_2O_3) has involved tremendous interest owing to its excellent and hopeful usages in the wavelength-calibration tools as well as pyrolysis catalysts [1,2]. To date, thermal decomposition route has been applied to prepare holmium oxide [3–6]. Precipitation way has been reported to be a reliable and facile way for the size and shape-controlled production of materials. It has been shown that fundamental characteristics of materials are a function of the shape and grain size. Recently, enormous efforts were made to optimize and control the shape and grain size of materials [7–23].

Herein, we offer a facile and efficient precipitation way for the synthesis of holmium oxide nanostructures applying triethylenetetramine as a novel precipitant and $Ho(NO_3)_3.6H_2O$ as a holmium precursor for the first time. The influence of different capping agents on the size, shape and photocatalytic behavior of holmium oxide was evaluated. It was found that the kind of capping agent has an effective role in shape, size and photocatalytic behavior control. The as-formed holmium oxide has been analyzed with applying EDX, FESEM, DR-UV–vis, TEM, XRD and FT-IR. The photocatalytic performances of as-obtained holmium oxide samples have been compared in the degradation of methyl violet contaminant under UV illumination.

2. Experimental

2.1. Materials and characterization

Methanol, propanediamine, $Ho(NO_3)_3 \cdot 6H_2O$, 2-hydroxy-1-naphthaldehyde,cetyltrimethyl ammonium bromide (CTAB),

Table 1
Reaction conditions for holmium oxide samples.

Sample no	Precipitant	Type of capping agent	Figure of FESEM images
1	Triethylenetetramine	Schiff base compound	1a and b
2	Triethylenetetramine	SDBS	1c and d
3	Triethylenetetramine	CTAB	1e and f
4	Triethylenetetramine	–	2a and b
5	NH_4OH	CTAB	2c
6	–	–	5c and d

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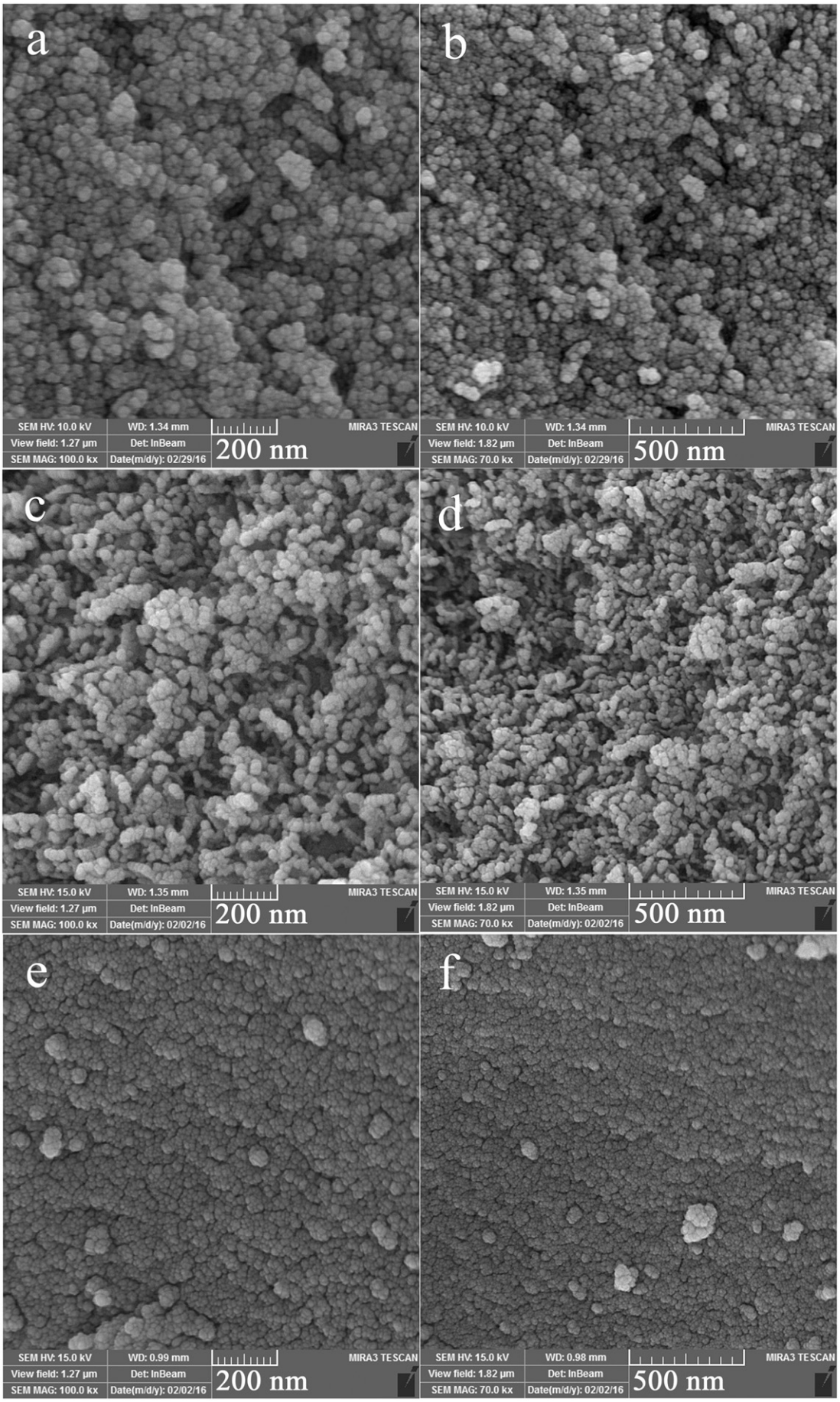

Fig. 1. FESEM images of the holmium oxide samples produced by applying Schiff base compound (a and b), SDBS (c and d) and CTAB (e and f).