$La(OH)_3$ and La_2O_3 Nanowires as Efficient Catalysts for Hydrogen Production via Sodium Borohydride Metanolysis

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Hydrogen is a clean energy carrier with high energy density, making it an attractive fuel option. Among various production methods, sodium borohydride ($NaBH_4$) methanolysis stands out for its safety, fast kinetics, and high hydrogen yield [1]. In this reaction, $NaBH_4$ reacts with methanol (CH_3OH) to produce hydrogen gas and sodium tetramethoxyborate ($NaB(OCH_3)_4$):

$$NaBH_4 + 4CH_3OH \rightarrow NaB(OCH_3)_4 + 4H_2 \qquad (1)$$

$NaBH_4$ is also non-toxic and non-flammable, enhancing its suitability for portable hydrogen systems. While many catalysts have been tested for this reaction, $La(OH)_3$ and La_2O_3 have not yet been studied. Given their catalytic potential, this work investigates hydrothermally synthesized $La(OH)_3$ and La_2O_3 nanowires as novel catalysts for $NaBH_4$ methanolysis, aiming to support sustainable hydrogen generation. The catalysts were characterized using XRD for phase identification, BET for surface area analysis, and FE-SEM for morphological examination. These techniques confirmed the structural and textural properties of the synthesized $La(OH)_3$ and La_2O_3 nanowire catalysts.

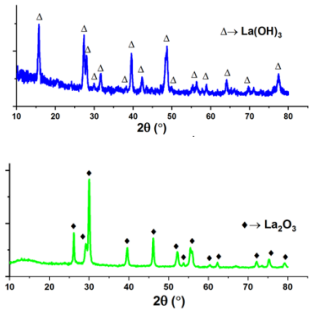

Figure 1. XRD patterns of $La(OH)_3$ and La_2O_3 nanowires.

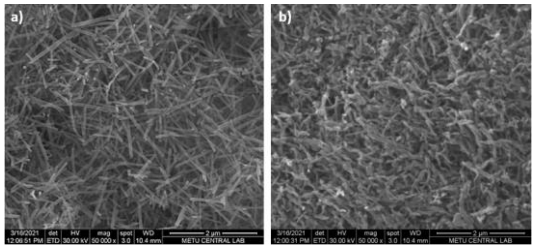

Figure 2. FE-SEM images of (a) $La(OH)_3$ (b) La_2O_3 nanowires.

Figure 1 demonstrates the formation of lanthanum oxides (La_2O_3) catalysts, while Figure 2 illustrate the FE-SEM images of the prepared $La(OH)_3$ and La_2O_3 nanowire catalysts. The specific surface area and total pore volume of the catalysts, as summarized in Table 1, show a significant decrease during the phase transformation from $La(OH)_3$ to La_2O_3.

Table 1. Specific surface area, and total pore volume.

Sample name	Specific surface area (m^2/g)	Total pore volume (cm^3/g)
$La(OH)_3$	35.4	0.190
La_2O_3	26.6	0.139

The experimental setup for $NaBH_4$ methanolysis and hydrogen gas measurement comprised a 50 mL jacketed reaction flask equipped with a Teflon-coated stir bar and placed on a magnetic stirrer. Temperature regulation was maintained by circulating water through the reactor jacket from a constant-temperature bath (PolyScience water bath). The evolved hydrogen gas was quantified using a graduated glass tube (50 cm in height, 2.5 cm in diameter) filled with water, which was connected to the reaction flask. Additionally, a thermocouple inserted into the reactor ensured precise temperature monitoring [2].

In this work, the catalytic performances of $La(OH)_3$ and La_2O_3 nanowires are systematically evaluated in terms of hydrogen yield, reaction kinetics, and stability under various operating conditions. The findings of this study provide valuable insights into the design of cost-effective and efficient catalysts for hydrogen generation, contributing to the advancement of clean energy technologies.

Acknowledgment
This work was supported by Kocaeli University Research Fund with Project Numbers: FAA-2025-4323.

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