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Supplementary Materials

Electrodeposition of a Li-Al Layered Double Hydroxide (LDH) on a Ball-Like Aluminum Lathe Waste Strips in Structured Catalytic Applications: Preparation and Characterization of Ni-Based LDH Catalysts for Hydrogen Evolution

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Abstract: A functionally structured catalyst was explored for ethanol steam reforming (ESR) to generate H_2. Aluminum lathe waste strips were employed as the structured catalytic framework. The mixed metal oxide (Li-Al-O) was formed on the surface of Al lathe waste strips through calcination of the Li-Al-CO_3 layered double hydroxide (LDH), working as the support for the formation of Ni catalyst nanoparticles. NaOH and $NaHCO_3$ titration solutions were, respectively, used for adjusting the pH of the $NiCl_2$ aqueous solutions at 50 °C when developing the precursors of the Ni-based catalysts forming *in-situ* on the Li-Al-O oxide support. The Ni precursor on the Al structured framework was reduced in a H_2 atmosphere at 500 °C for 3 h, changing the hydroxide precursor into Ni nanoparticles. The titration agent (NaOH or $NaHCO_3$) effectively affected the physical and chemical characterizations of the catalyst obtained by the different titrations. The ESR reaction catalyzed by the structured catalysts at a relatively low temperature of 500 °C was studied. The catalyst using $NaHCO_3$ titration presented good stability for generating H_2 during ESR, achieving a high rate of H_2 volume of about 122.9 L/(g_{cat}·h). It also had a relatively low acidity on the surface of the Li-Al-O oxide support, leading to low activity for the dehydration of ethanol and high activity to H_2 yield. The interactions of catalysts between the Ni precursors and the Li-Al-O oxide supports were discussed in the processes of the H_2 reduction and the ESR reaction. Mechanisms of carbon formation during the ESR were proposed by the catalysts using NaOH and $NaHCO_3$ titration agents.

Keywords: structured catalyst; ethanol steam reforming; aluminum lathe waste strips; layered double hydroxide; Ni nanoparticle

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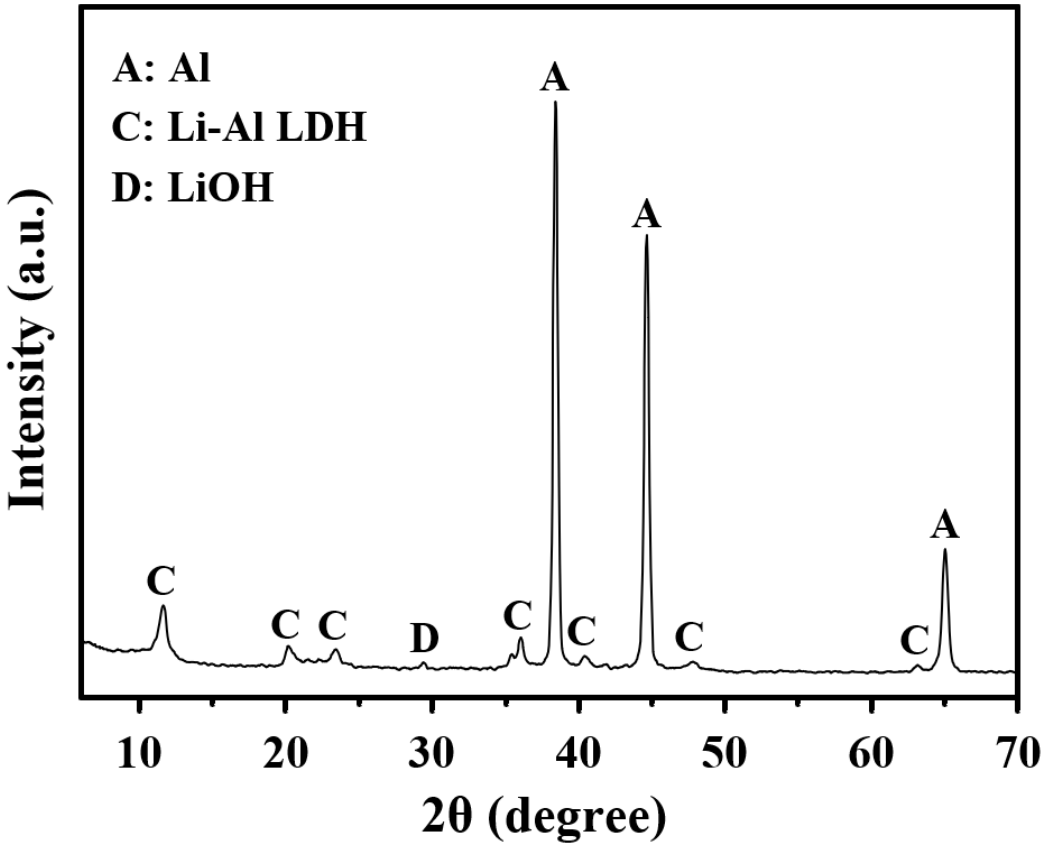

Figure S1. XRD pattern of the Li-Al LDH thin film on Al (A6061) substrate by electrochemical deposition.

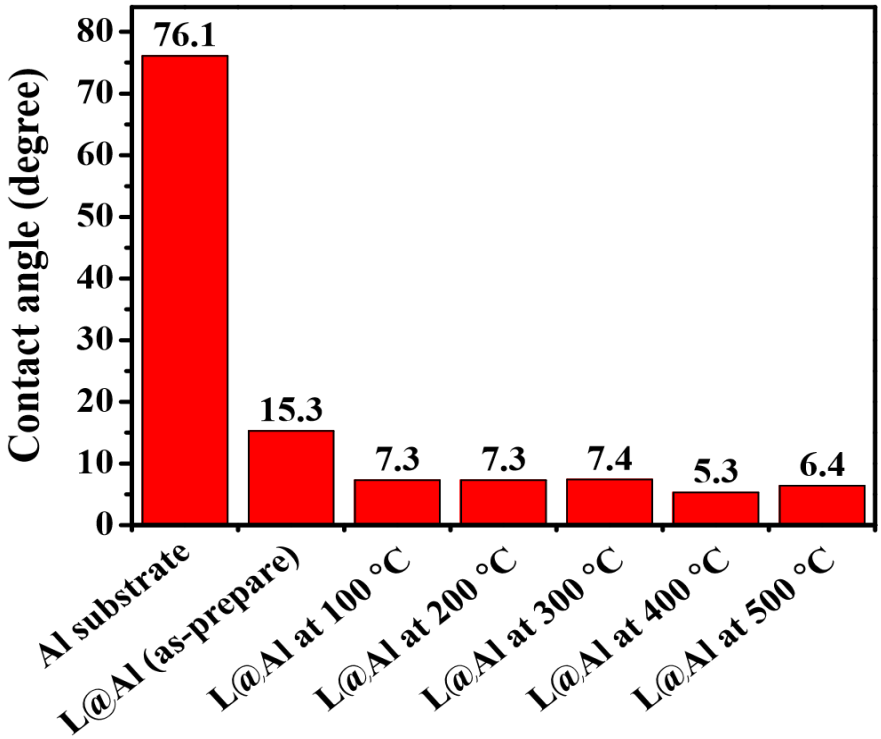

Figure S2. Water contact angle on the Al substrate, Li-Al LDH thin film @ Al substrate (L@Al), and Li-Al LDH thin film @ Al substrate (L@Al) after calcination at various temperatures.

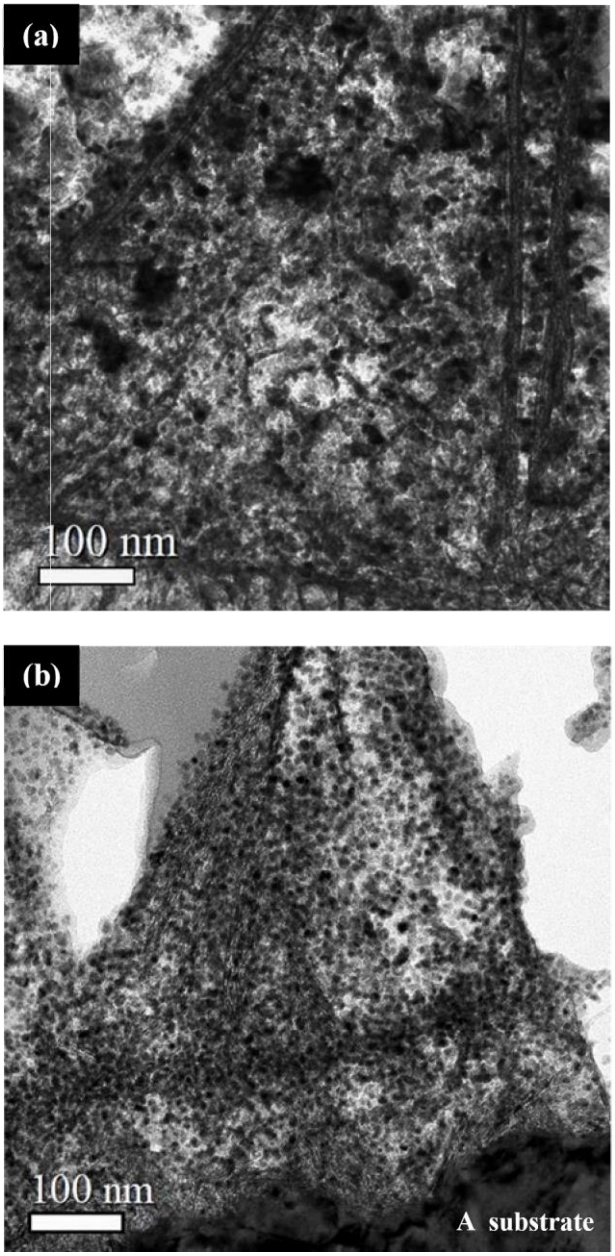

Figure S3. TEM bright-field images showed the distributions of Ni particles on the calcined LDH supports for the samples: (a) NaOH_T + R and (b) $NaHCO_3$_T + R.