**Supporting Information**

**Synthesis of Ni-Mg@HC catalyst derived from sugarcane bagasse and its application for producing syngas via CO2 dry reforming**

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**Catalyst characterization**

The CO2-TPD measurements (Auto Chem II 2920) were conducted on reduced catalysts to analyze the adsorption capacity of CO2. 20 mg catalyst (200 mesh) was reduced in-situ under He flow at 200 °C for 1 h to remove physically adsorbed species. Then, CO2/He mixed gas was then passed over sample at 50 oC for 30 min (30 mL·min-1) to carry out the CO2 adsorption. Temperature was then linearly increased up to 850 oC at 10 oC·min-1 and TPD signals were recorded with thermal conductivity detector (TCD) detector.

The N2 adsorption-desorption measurements were determined to analyze the specific surface area, pore volume and pore diameter values of Ni-Mgx@HC catalysts on a Micromerictics ASAP 2020 apparatus at -196 oC by following BET-BJH method. For each analytical run, 4 h degassing was performed for about 0.1 g of the catalyst at 120 oC before quantification.

The XRD analysis were performed at a RINT2000 vertical goniometer at a scanning rate of 2o/min from 10o to 90o using a CuKɑ(λ=1.54056Å) radiation, which was used to characterize the crystalline phases. The particle size of the sample can be calculated by Scherrer Equation:



Where D is the average crystallite size (nm), K is the shape factor, usually taken as 0.89, λ is the wavelength of incident radiation (0.15406 nm), β is the half-height width of the most intense peak for the species (radians), and θ is the Bragg angle (o) of that peak.

Transmission electron microscopy (TEM) was carried out to characterize the morphology of catalyst using a FEI Tecnai G2 F30 transmission electron microscope operated at 10 kV for observing the interior porous structure.

The data of TG-DTG was collected using a Simultaneous Thermal Analyzer (STA 449F3) by estimating the weight loss of the sample after combustion of the carbon components to provide a clearer understanding of the carbon deposition on the catalysts. The TG and DTG curves were obtained at the following conditions. Approximately 10 mg of catalysts were packed into ceramic crucible, and heated from room temperature to 850 oC under air flow rate of 60 ml·min-1 with a heating rate of 10 oC·min-1.

The ex-situ FTIR analysis was conducted to determine the adsorption of CH4 and CO2 on the catalyst surface. Prior to experiment, the sample was mixed with KBr at 1:100-200 (V/V), ground, and sieved with a 200 mesh size, then placed in a tablet press to be pressurized to 10 MPa. The spectra were collected in the range of 4000-400 cm-1, which accumulated 16 scans at 4 cm-1 resolution.

The in-situ DRIFTS experiment was performed on a Bruker Tensor II spectrometer equipped with liquid nitrogen cooled mercury cadmium telluride (MCT) detector and a Harrick DRIFT cell containing ZnSe window. The reduced catalyst was loaded in the temperature chamber and heated under CO2 flow of 20 ml·min-1 from room temperature to 600 oC at a heating rate of 10 oC·min-1. The DRIFTS spectra were collected in the range of 4000-400 cm-1, which accumulated 16 scans at 4 cm-1 resolution. The DRIFTS spectra were recorded every 5 min.



**Fig.S1**.The stability test for Ni-Mg15@HC catalyst at 850 oC.



**Fig.S2**.FTIR pattern of reduced and used Ni-Mg15@HC catalyst.





**Fig.S3**.In-situFTIR pattern of the reduced Ni@HC (a) and reduced Ni-Mg15@HC (b) catalysts in CO2 atmosphere under different temperature