Nano-engineered Catalyst for the Utilization of CO_2 in Dry Reforming to Produce Syngas

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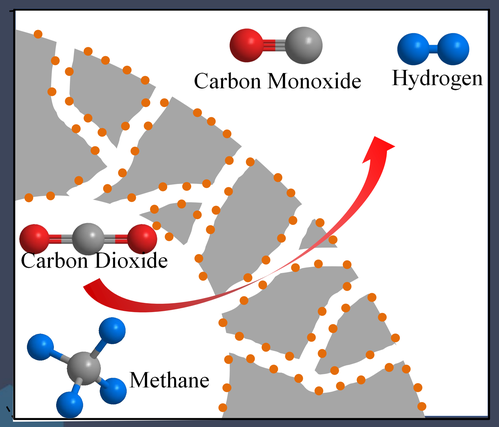
BACKGROUND

Dry reforming of methane

- **Reaction: $CH_4 + CO_2 \rightarrow 2H_2 + 2CO$**
  - Different from methane steam reforming ($CH_4 + H_2O \rightarrow CO + 3\ H_2$)
- **Syngas**: feedstock for fuels and chemicals production
- **Typical catalysts**:
  - **Precious metals** (Pt, Rh, Ru): expensive
  - **Low-cost Ni**: issue of sintering of the Ni particles and coking

MOTIVATION

Nano-engineered Ni catalyst prepared by atomic layer deposition (ALD) may resolve sintering and coking issue

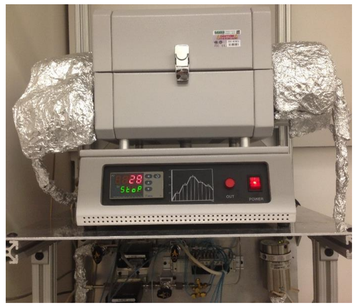


OBJECTIVE

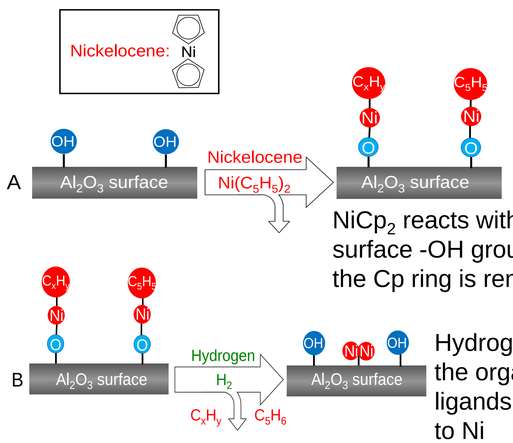
Develop nano-engineered catalyst supported on high-surface-area ceramic hollow fibers for the utilization of CO_2 in dry reforming of methane ($CO_2 + CH_4 \rightarrow 2\ H_2 + 2\ CO$) to produce syngas

CATALYST DEVELOPMENT

ALD Reactor



ALD procedure

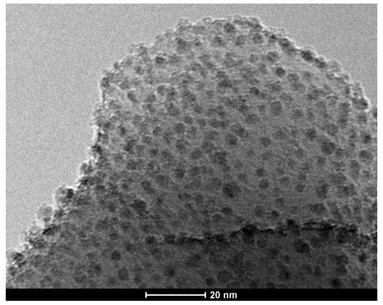


$NiCp_2$ reacts with the surface -OH groups and the Cp ring is removed

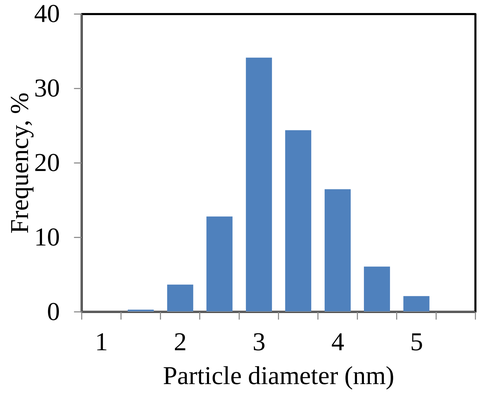
Hydrogenate the organic ligands bound to Ni

c Catalysts are calcined in air at 550 °C

CATALYST CHARACTERIZATION



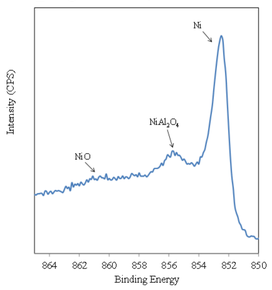
TEM image of α-Al_2O_3 nanoparticle-supported Ni catalysts



Particle size: 2-6 nm, average 3.1 nm

- Particles prepared by traditional methods (e.g., incipient wetness) are ~10-20 nm

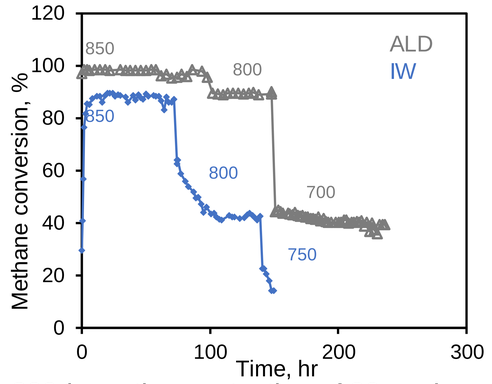
X-ray photoelectron spectroscopy analysis of α-Al_2O_3 nanoparticles supported Ni catalysts



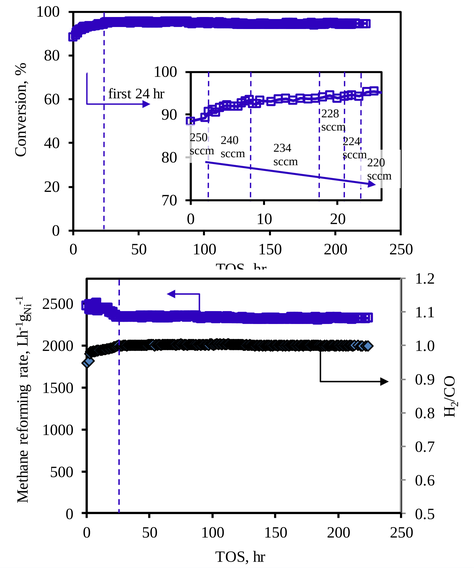
- In addition to Ni and NiO, $NiAl_2O_4$ spinel formed during Ni ALD, which increases Ni-support interaction

DRY REFORMING PERFORMANCE

ALD Ni catalyst showed advantages over traditional catalysts prepared by incipient wetness (IW)



200-h continuous testing of 20-cm long hollow fiber supported Ni ALD catalyst indicated good stability (no sintering and coking issue)



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