Synthesis of Ni/γ-Al2O3 catalysts by the sol-gel method for the catalytic reforming of glycerol

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Summary
Nickel supported gamma alumina catalysts have been developed for the use in glycerol reforming applications. The catalysts were developed using the sol-gel method and characterized using TPR, BET, XRD, TEM and ICP techniques. The catalysts were prepared with different precursors of Ni, Al2O3, solvents and silicon precursors in order to determine the texture, morphology and crystallographic properties of each catalysis and select the best preparation route. It was developed a synthesis sol-gel procedure for the cogelation between the functionalized silicon precursors and alumina precursors. From the results obtained, it was observed that the catalysts prepared with nickel acetate, 2-methoxyethanol and EDAS present a great stability in their structure, the presence of γ-Al2O3 was confirmed by XRD analysis, Ni metal particles doped in gamma alumina were noted using TEM analysis.

Introduction
Significant amount of glycerol is produced as a by-product during bio-diesel production by transesterification of vegetable oils, which are available at low cost in large supply from renewable raw materials.

Using glycerol as a source of producing hydrogen is a good possibility. Steam reforming is a promising way to utilize the diluted glycerol aqueous solution to produce hydrogen.

C3H5O3(g) + 3H2O(g) → 3H2(g) + 3CO2(g)  [1]

Catalysis plays an important role for this proposal. Usually, nickel-based catalysts are used in the reforming of glycerol; however, the major problem associated with nickel catalysts is coke formation. The most common catalyst supports in the reforming of hydrocarbons to hydrogen are γ-Al2O3, γ-Al2O3, MgO, MgAl2O4, SiO2, ZrO2, CeO2 and TiO2.

The sol-gel process provides a new approach to the preparation of functionalized silicon precursors and alumina precursors.

Synthesis by the sol-gel method

Characterization Results

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Characterization Results

Table 1: Crystal size calculation for a) Ni(Å)Al2O3 b) Ni(Å)Al2O3 c) Ni(Å)Al2O3 d) Ni(Å)Al2O3.

Conclusions

• The catalysts presented a BET surface area between 250-515 m2/g and an average pore size between 2 to 7 nm.
• The addition of EDAS modified the properties of γ-Al2O3. The formation of small and spherical γ-Al2O3 crystals is directly related to the functionalized chain of EDAS.
• Ni/Al2O3 catalysts based on different precursors present distinct characteristics in nickel dispersion, reduction degree, and particle size.

References


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