Title:

Synergy of non-thermal plasma with Ni/CeO2 catalysts for CO2 recycling

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Abstract:

The use of CO2 has great potential to complement greenhouse emission reduction strategies and to establish a sustainable and circular economy that exploits CO2 not as an emission but as a carbon reservoir to produce value-added compounds. Innovative technologies such as non-thermal plasmas are being explored for CO2 activation and reduction. The combination of plasma and catalysis for the conversion of CO2 allows the direct application of renewable electricity in an efficient way. Its application in the catalytic methanation of CO2 takes advantage of the synergy between the ionized species in the plasma and their contact with the catalytic material to favor the reaction.

In this work, plasma-assisted catalytic methanation has been studied in a fixed bed Dielectric Barrier Discharge (DBD) reactor supplied by a high voltage, alternating current power source with 27 kHz frequency and 20 kV peak-to-peak voltage. Several materials were tested in this DBD reactor, including CeO2 support and Ni/CeO2 catalyst. An optimization of the physicochemical properties of the catalysts used in plasma-assisted reactions is required in order to exploit the synergy between catalyst and plasma, as small particle size, high specific surface area, optimal basicity for CO2 adsorption, oxygen vacancy formation, and low dielectric permittivity.

It is observed that high conversion and selectivity can be obtained at temperatures around 200 °C when the Ni containing catalyst is used compared to the negligible effect of the ceria support only. Such results are in line with previous work carried out with other materials at comparable conditions. It can be concluded that Ni/CeO2 materials are promising catalysts for plasma-assisted CO2 methanation, which proves to be more efficient than the conventional thermal catalysis process.