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Study of plasma catalyst interactions by time resolved diffuse reflectance infrared Fourier transform spectroscopy

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Cold atmospheric pressure plasma (CAP) assisted thermal catalysis has shown promise to enhance catalytic efficiency by a process called plasma-catalyst synergy (PCS). The overall goal of this work is to obtain mechanistic insights on surface phenomena in PCS. The system under investigation is partial oxidation of methane using a Ni supported catalyst assisted by an atmospheric pressure plasma jet (APPJ). The evaluation of gas phase and surface changes as a function of feed gas composition, catalyst temperature and time provides information on plasma-catalyst interaction during the chemical conversion process. In prior work by our group, results of remote gas phase characterization by IR absorption spectroscopy has been reported for this system A synergistic effect of plasma assisted catalysis was observed for gas phase CO production. The synergistic effect is found to be strongly enhanced by plasma power and reduced for increased catalyst temperature. In this work we complement these results with the measurement of the surface response of the supported Ni catalyst assisted by the APPJ by diffuse reflectance infrared Fourier transform spectroscopy (DRIFTs). A synergistic effect for surface bonded C-O was observed during the exposure of the Ni catalyst to the APPJ for low oxygen conditions. When the supported Ni catalyst was subjected to the plasma-generated particle fluxes for highly oxidizing conditions, the presence of surface bonded C-O was suppressed. The surface behavior of C-O correlates with the measured plasma-catalytic CO production in the gas phase measured downstream when plasma source is switched from low oxygen portion case to a high oxygen portion case, especially at high catalyst temperature (500 oC). The behavior of other surface adsorbed species, e.g. CHx, for different plasma-catalyst operating conditions will also be reported and discussed.
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