Effect of surface porosity on plasma assisted catalysis for ammonia synthesis

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The fundamental understanding of plasma-catalytic interaction and reaction mechanism is important in optimizing the catalyst design and increasing the efficiency of plasma-enhanced catalytic process for ammonia (NH_3) synthesis. In this work, we have reported the effect of surface porosity of catalytic support on plasma- assisted ammonia synthesis from nitrogen and hydrogen. The experiments were performed using a coaxial dielectric barrier discharge (DBD) plasma reactor with variable applied voltage at room temperature and near atmospheric pressure (550 torr) where porous silica (SiO2) and smooth soda lime glass beads of equal diameter are used for comparison. N_2 conversion, ammonia synthesis and energy yield were traced at varying voltage and were found to be higher in the case of silica which suggest that porous materials are better as compared to smooth surfaces for plasma-enhanced ammonia synthesis. The discharge characteristic shows that the effect of different catalytic support on the physical properties of the discharge was almost negligible. High resolution optical emission spectra (OES) were used to explore the evolution of reactive gas phase species (N_2^+, N, H_α, H_β, N_2) in presence of both materials. The relative concentration of these gas phase species was higher in the case of glass regardless of applied voltage which suggests that gas phase reactions were dominant for smooth surfaces. However, higher conversion of ammonia with porous material signifies that chemistry of the catalyst surface is dominant over the gas phase reactions and physical effects of the catalysts in the plasma-catalytic synthesis of ammonia. A zero-dimensional (0D) kinetic model [1,2] has been performed to understand the underlying mechanism of porosity effect on plasma assisted ammonia synthesis.

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[1] S. Pancheshnyi et al., 2008 Computer code ZDPlasKin (www.zdplaskin.laplace.univ-tlse.fr)

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