Synergistic effect of non-thermal plasma-catalysis hybrid system on methane complete oxidation over Pd-based catalysts

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The complete oxidation of methane was carried out in a dielectric barrier discharge (DBD) quartz tube reactor where both catalyst and plasma were hybridized into one in-plasma catalysis system. The palladium-based catalysts such as Pd/Al_2O_3, Pd/SiO_2, and Pd/TiO_2 were used as oxidation catalyst. In the absence of catalyst, methane began to be oxidized to CO and CO_2 even at room temperature. However, large amount of CO were also produced in addition to CO_2, especially at low temperature below 200 degree Celsius when plasma was only used. In the presence of both plasma and catalyst, methane was oxidized to produce mostly CO_2 with low CO selectivity at room temperature, indicating that the complete oxidation was successfully performed with the aid of catalyst. The role of plasma was to oxidize CH_4 to produce CO, which was subsequently oxidized to CO_2 over catalyst at low temperature. Hence, in most cases, the methane conversion of plasma-catalysis hybrid system was almost equal to the summation of two separate systems. Interestingly, it was found that the synergistic effect of plasma-catalysis hybrid system on methane oxidation existed substantially only under specific condition.