# Plasma-assisted Fluidized-bed Atomic Layer Deposition of Pd and Pd-Cu catalysts

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A fluidized-bed plasma enhanced atomic layer deposition process is reported to fabricate Pd nanoparticles using palladium hexafluoroacetylacetonate precursor and $H_2$ plasma. The process successfully deposits Pd nanoparticles over porous γ-$Al_2O_3$ (30 wt%), amorphous aluminum silicate (50 wt%) and molecular sieve (20 wt%) (ASM) supports. Transmission electron microscopy reveals that high density Pd nanoparticles were uniformly distributed over the entire ASM supports and the average Pd particle size was sensitive to the number of PEALD cycle. The catalytic activities of the different particle sizes and Pd loading samples were evaluated for CO oxidation. With the metal loading amount of 2% for Pd in the average particle size of 3.32 nm, the deposited Pd/ASM sample shows an excellent catalytic activity for CO oxidation, i.e. 100% CO was converted at as low as 140 °C.

Pd-Cu nanoparticles on ASM powder has also been successfully utilized in the $CO_2$ hydrogenation. The metal loadings of 13.1 and 2.5 mg/g for Pd and Cu, respectively, shows excellent catalytic performance in a dielectric barrier discharge reactor without external heating. Under the conditions of the discharge input power of 24.6 W, $H_2$-to-$CO_2$ ratio of 4 in feed gas, and gas hourly space velocity of 7595 $h^{-1}$, the conversion of $CO_2$ reaches as high as 38.0%, and the $CH_4$ and $CH_3OH$ product selectivities are 6.7% and 12.8%, respectively.

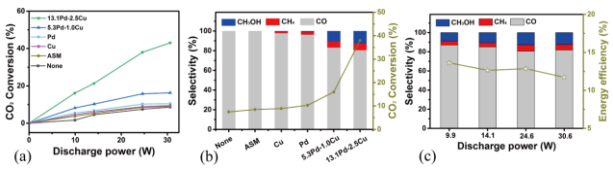


**Figure** (a) $CO_2$ conversion over various catalysts under different discharge power. (b) Selectivity and $CO_2$ conversion under the discharge power of 24.6 W. (c) Selectivity and energy efficiency over the 13.1Pd-2.5Cu catalyst under different discharge power.

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