ACS-PRF # 47369-AC5 – Nugget

It is well known that gold is an inert material that cannot be used for chemical reactivity. This view, however, dramatically changes when the size of gold particles drops to the nanometer scale. It was demonstrated in recent years that gold particles about 3nm in diameter may be an excellent CO oxidation catalysts at particularly low temperatures. We have modified small gold particles and grew them as bimetallic Au-Pd nano-particles using the buffer layer assisted growth (BLAG) mechanism. This technique enables us to deposit cold metallic particles and to control their size and surface density independently. Probably the most exciting outcome of our research so far has been a unique demonstration how manipulation of the structure of clusters to form bimetallic Au-Pd crystalline alloy leads to particularly high reactivity towards the conversion of acetylene to ethylene and benzene. The graphical summary of the preparation procedure is demonstrated in Fig. 1 while the very low temperature (200-250K) chemical reactivity of these clusters is shown in Fig. 2.

The main future challenge employing such clusters will be to stabilize them on the surface to avoid their surface diffusivity towards sintering. This process may deactivate the catalyst. We have so far obtained preliminary results showing that surface defects prepared by energetic ion-sputtering indeed lead to such enhanced stability.

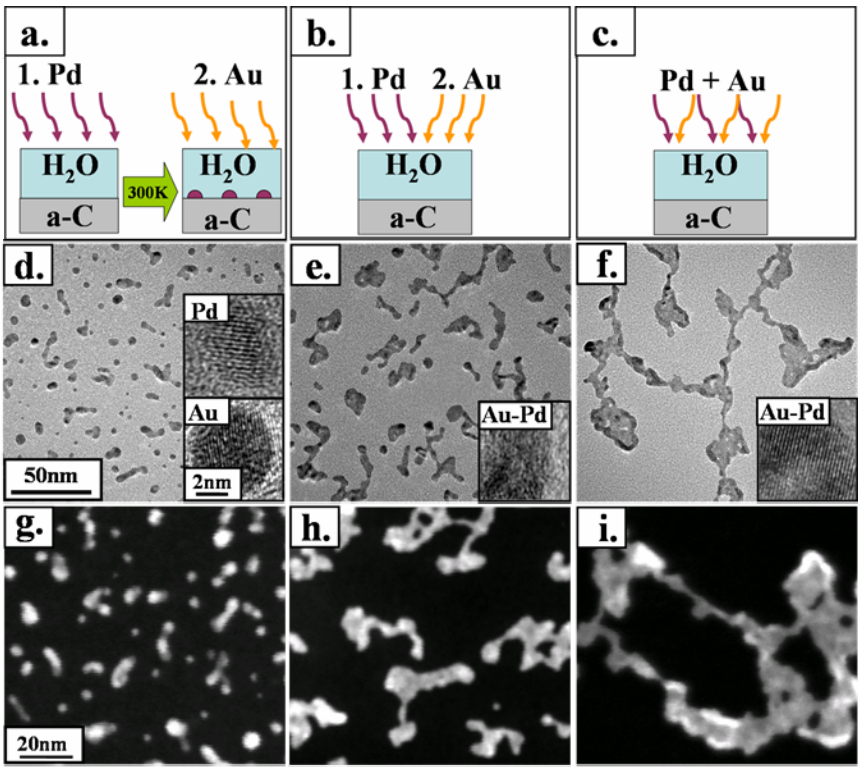

Figure 1: Pd-Au clusters prepared by three different methods: (A) Two consecutive BLAG procedures on 100ML ASW at 120K as buffer, the first with Pd, the second with Au (Type A clusters- Fig. 1a). (B) Evaporation of palladium first then of gold on top of the same ASW buffer layer (type B clusters- Fig. 1b). (C) Simultaneous evaporation of gold and palladium on top of the same ASW buffer layer (type C clusters- Fig. 1c.). TEM images of types A, B and C clusters are shown in Figs. 1d, 1e and 1f, respectively, HR-TEM atom resolved images are shown in the respective insets. STEM images of types A, B and C clusters are presented at higher magnification in Figs. 1g, 1h and 1i, respectively.

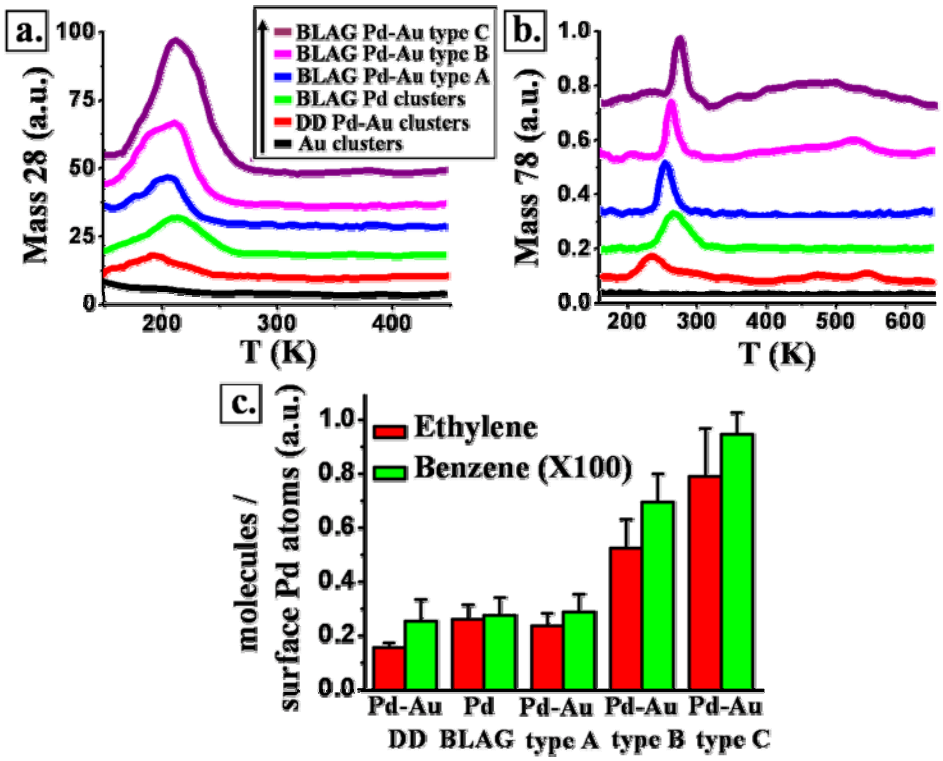

Figure 2: Temperature Programmed Reaction (TPR) of ethylene (mass28) (a) and benzene (mass 78) (b) collected following adsorption of 2L C_2H_2 on the different clusters at 120K, heating rate was fixed at 3K/sec. Estimated relative reactivity towards ethylene and benzene formation per surface Pd atoms for the different clusters (c).