Stabilization and reverse-engineering of gold nanoparticles in silica aerogels for static and continuous-flow catalytic applications

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Nanogold is a preferred catalyst in a number of applications. However, recovery of that for further use from the reaction mixtures cannot be accomplished in most of the cases. Immobilization of nanogold in a chemically resistant silica aerogel matrix would offer the possibility of combining the advantages of an immobilized catalyst and a highly porous and easily penetrable solid support. Unfortunately, the standard synthetic conditions led to rapid aggregation of the citrate-stabilized nanoparticles and the loss of catalytic activity. Changing the solvents and the gas atmosphere revealed that atmospheric carbon dioxide plays a critical role in the aggregation process. Providing a protecting atmosphere and testing several types of polymeric materials resulted in the solution, in which polyvinylpirrolidone (PVP) served as a protecting polymer which prevented the formation of the Au aggregates and allowed the preparation of nanogold-containing silica aerogels.[1] Further studies revealed that by changing the temperature and advantageously exploiting the dimensional changes of the matrix, larger than 100 nm gold particles can be reverse-engineered into the 10-40 nm range.

Catalytic activity of the as-prepared aerogels was tested by sodium hydroborate reduction of p-nitro phenol to p-amino phenol at room temperature monitored by UV-Vis spectroscopy. We have found that atmospheric oxygen acts as an inhibitor of the process. The reduction was performed also in a specially designed continuous-flow chemical reactor prepared by rapid prototyping technique. It has been found that careful control of the flow rates and the concentrations leads to a well-controllable way of continuos operation.

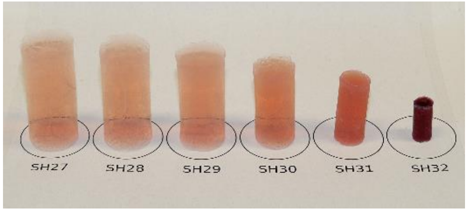

Figure 1: Nanogold-containing silica aerogels sintered at increasing temperatures up to 1000 °C still preserving tha particles sizes.

Reference: [1] Lázár, István ; Szabó, Hanna Judit, Prevention of the Aggregation of Nanoparticles during the Synthesis of Nanogold-Containing Silica Aerogels
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