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Abstract

How a piece of shiny gold can play a unique role as a catalyst when utilized in a nanoscale-based system

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Abstract:
Gold nanoparticles immobilized on powder Norit activated carbon (Au101/AC) via colloidal deposition gave high selectivity of benzyl alcohol oxidation. The presence of K2CO3 as a base increased the catalytic activity of gold nanocatalysts through dehydrogenation of the alcohol via deprotonation of primary OH groups and helped overcome the rate-limitation step of the oxidation process. The interaction between the gold species and the support was investigated by measuring the change in the catalytic activity with different activation methods i.e., washing with a solvent at elevated temperature, and/or followed by activation. A mixture of benzyl alcohol as a reactant, methanol as a solvent, K2CO3 as a base, and oxygen gas was studied by the activated gold nanocatalysts by using a mini reactor set-up. The efficiency of the process was explored by varying the amounts of benzyl alcohol and the base, target temperature, metal loading of the gold catalysts rate, and the solvent between 3 and 24 h at 73 psi O2 and 750 rpm stirring rate. The samples of the reaction mixture were centrifuged and analysed by high-performance liquid chromatography to determine conversions.

The effect of size on the catalytic activity was studied for different types of gold particles (i.e., Au101, Aunaked, and Aucitrate) and clusters (i.e., Au8 and Au9) immobilized on powder Norit activated carbon. The highest activity of benzyl alcohol oxidation was observed for activated 1.0 wt% Au101/AC catalysts when washed with toluene and followed by activation under vacuum at 100 oC for 3 h, for ~3.5 nm gold particles. Additionally, the support effect was studied for gold particles immobilized on different types of carbons powder Norit activated carbon, mesoporous carbons (i.e., CMK-3, CMK-8, and NCCR-41), and also Vulcan carbon. The highest activity was observed by activated 1.0 wt% Au101/CCMK-8 catalysts when washed with toluene and followed by activation under vacuum at 100 oC for 3 h. Activated 1% Au101/CNCCR-41 (washed with toluene followed by activation under vacuum at 100 oC for 3 h) with 2.6 ± 0.1 nm gold particle size showed the highest selectivity towards methyl benzoate as the main product (S%: 88%) after 3 h reaction time. However, activated 1% Au101/C (activation in O2 -H2 at 100 oC for 3 h) with 6.6 ± 0.3 nm gold particle size exhibited the highest selectivity towards benzoic acid as the main product (S: 86%) after 24 h reaction time. Therefore, particle size and type of carbon support can be considered as playing crucial roles in defining the catalytic activity of gold nanocatalysts which were used for benzyl alcohol oxidation.

Biography:
Sedigheh Ghadamgahi joined Prof. Khodadi team at the University of Tehran (UT) as post-fellow in 2015 for the research of heterogeneous nanocatalysts in the gas-phase reactions. Before that, she completed her Ph.D. at the University of Canterbury (UC) in nanochemistry under Dr. Vladimir Golovko and Prof. Bryce Williamson supervision, where she conducted research on heterogeneous nanocatalysts in liquid-phase reactions, and also tutored chemistry labs. Prior to joining the UC, she did her masters in analytical chemistry at Urmia University as Dr. Khalili Farhadi's team and lectured papers in chemistry at the Islamic Azad University in Tehran, Iran. Dr. Ghadamgahi is interested in heterogeneous nanocatalysts fabrication, application, and characterization. She has focused on nanostructure materials, such as polymers, complexes, clusters, composites, particles, colloids, and particularly catalysts.

Publication of speakers:

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