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Heating or Cooling : Temperature Effects on the Synthesis of Atomically Precise Gold Nanoclusters (Article)

Chen, T., Yao, Q., Yuan, X., Nasaruddin, R.R., Xie, J.

Department of Chemical and Biomolecular Engineering, National University of Singapore, 4 Engineering Drive 4, Singapore, 117585, Singapore

Abstract

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Developing an efficient, well-controlled synthesis strategy for gold nanoclusters (Au NCs) is crucial for delivering their expected applications in many fields; and such development requires fundamental understandings on the synthetic chemistry. The synthesis of Au NCs typically consists of a pair of reversible reactions: a fast reduction-growth reaction and a slow size-focusing reaction. Here we demonstrate that the above two reactions can be well-balanced while accelerated in a heated synthesis protocol, thus providing an efficient and scalable synthesis method to obtain thermodynamically favorable $Au_{25}(SR)_{18}$ NCs (SR denotes thiolate ligand) with high yield (>95% on gold atom basis) and fast kinetics. By investigating the Au NC formation behavior at different temperature, we identified the endothermic nature of the reductive formation of $Au_{25}(SR)_{18}$ NCs from Au(I)-thiolate complex precursors. More interestingly, if overheated, after the formation of $Au_{25}(SR)_{18}$, there exists an irreversible first-order reaction, which could transform $Au_{25}(SR)_{18}$ into Au NCs of mixed sizes. As a result, 40 °C is identified as the optimal temperature to synthesize $Au_{25}(SR)_{18}$ in aqueous solution, as the half-life of the transformation reaction (67.8 h) is much longer than the time needed to obtain high yield $Au_{25}(SR)_{18}$. The detailed understandings on the temperature effects of Au NC synthesis would facilitate the development of efficient synthesis strategies for atomically precise Au NCs with predesigned size, composition and structure. © 2016 American Chemical Society.

SciVal Topic Prominence

Topic: Nanoclusters | Gold | fluorescent gold

Prominence percentile: 99.923

Reaxys Database Information

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Indexed keywords

Engineering controlled terms: Gold, Nanoclusters, Planning, Solutions, Temperature

Engineering uncontrolled terms: Complex precursors, Controlled synthesis, Efficient synthesis, First order reactions, Optimal temperature, Reversible reaction, Synthetic chemistry, Transformation Reactions

Engineering main heading: Chelation

Metrics

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