

Synthesis of Gold Nanoparticles from Plasma Chemistry

Qiang Chen

¹ Shenzhen Research Institute of Xiamen University, Institute of Electromagnetics and Acoustics, Fujian Provincial Key Laboratory of Plasma and Magnetic Resonance, Key Laboratory of Electromagnetic Wave Science and Detection Technology, Xiamen University, Xiamen 361005, China

e-mail (speaker): chenqiang@xmu.edu.cn

Discharge plasma includes plenty of charged particles as well as reactive species, which will lead to a plasma-induced electrochemistry if the gaseous plasma is in contact with a solution^[1]. The plasma-liquid interactions generated at the plasma-liquid interface can cause several important physical and chemical processes in the plasma-liquid system. This plasma electrochemical processes provides a novel tool for nanoparticles formation due to the multiple reactive species produced by the plasma-liquid interactions.

In order to control the synthesis process and final formed nanoparticles, it is important to specify the responsible reducing species from potential reductants produced in the plasma electrochemical processes. For a solution with metal ions, the reducing species might be solvated electrons, atomic hydrogen, molecular hydrogen etc. which are usually produced in an aqueous solution exposed by a plasma. However, in many cases, it is not clear that all or partial of these species takes effect on the metal ions' reduction process. Herein, we explore the reducing species in gold nanoparticles formation from a plasma treated aqueous solutions of hydrogen tetrachloroaurate-(III) trihydrate ($\text{HAuCl}_4 \cdot 3\text{H}_2\text{O}$)^[2]. A DC power source is applied to ignite two discharge

plasmas which are in contact with an H-type electrochemical cell containing an aqueous solution of HAuCl_4 . The solution contained in one cell acts as a cathode, and in the other as an anode. Gold nanoparticles are formed after the plasma exposure of the solution. A simple survey suggests that the hydrogen peroxide and solvated electron is the main reducing species for gold nanoparticles formation from an aqueous solution of HAuCl_4 , while the reducing function of the atomic hydrogen and H_2 are negligible. Moreover, the pH value of the HAuCl_4 solution can be used to tune the formation processes and the final form of the gold nanoparticles due to its mediation of reductants.

References

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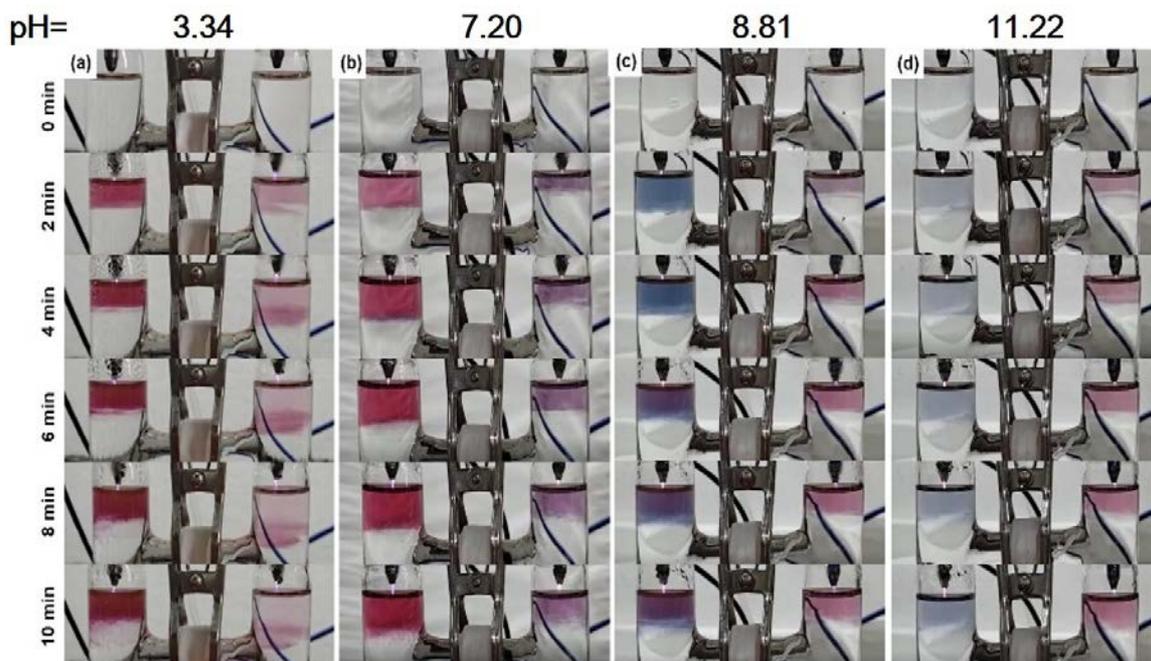


Figure 1. Images of discharge plasma treated aqueous HAuCl_4 solutions with different pH values in H-type electrochemical cells. The solution in the left cell acts as the cathode, and in the right cell acts as the anode.