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Synthesis of metal nanoparticles from DC discharge plasmas insider a solution

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Plasmas in contact with liquids provide a novel reaction zone for synthesizing many chemicals and materials [1-3]. When plasma is operated inside liquid, the gaseous reactive species generated via the plasma-liquid interactions can efficiently transport into the liquid phase, which makes the plasma insider water is more suitable for materials synthesis, compare with the plasma generated over a liquid surface. This work designs a DC liquid discharge plasma device, which overcomes the disadvantage that liquid discharge usually requires expensive high-voltage alternating current power supply. The device is mainly composed of a pair of tungsten wire electrodes, respectively, wrapped in a capillary quartz tube, one electrode tip is insider the capillary tube, and the other electrode extends out of the capillary tube. When the two capillary quartz tubes are immersed in the liquid, there will be a small gas gap between the tungsten wire electrodes that do not protrude from the capillary tubes and the liquid. A discharge plasma can be ignited and sustained between the gas gap by applied a DC voltage. The reactivity of the plasma can be converted into the reactivity of the liquid through the plasma-liquid interface, so the device can be used in various fields, such as plasma activated water, pollution control, nanomaterial synthesis, nitrogen fixation and hydrogen peroxide synthesis, etc.

Based on the anodic dissolution, we used this plasma source to synthesize several metal nanoparticles, including gold, silver, copper nanoparticle by using respective metallic anode material, and the properties of nanoparticles can be tuned by the discharge parameters such as electrode configuration, solution composition, discharge current etc. Figure 1 presents the case of synthesis of gold nanoparticles. Obviously, the typical localized surface plasmon resonance appears at the absorbance of the plasma treated solutions. We also discussed the formation processes of the gold, silver, and copper nanoparticles at different solution and plasma parameters.

References

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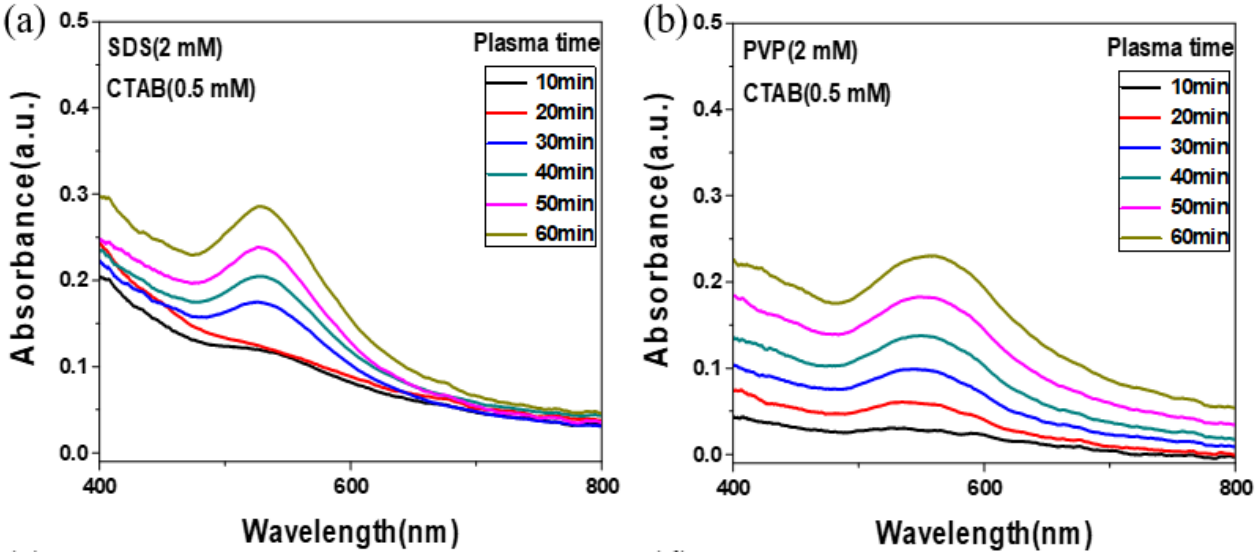

Figure 1. Absorbance of plasma treated aqueous solutions with different surfactant componenets of (a) SDS/CTAB, (b) PVP/CTAB. Gold wire acts as the gold precursor released by anodic dissolution.