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Contact non-equilibrium plasma for colloidal nanoparticles synthesis

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In recent years there has been a tremendous growing interest in the field of gold nanoparticles (AuNPs) and their applications with a range of synthesis methods for metal NPs that are being investigated or that are currently in use (e.g. chemical synthesis by using reducing and capping agent, biosynthesis, laser ablation method etc). Current synthesis approaches, however, still present limitations that relate to the quality of the synthesized materials in terms of size and shape, process cost and complexity, safety, production rate, throughput etc [1].

The contact non-equilibrium plasma offers enhanced opportunities over solution chemistry for synthesis new nanomaterials and tailoring their functional properties. This synthesis technique does not need any added reducing and/or capping agents and only requires a water-based solution with the metal precursor. Contact non-equilibrium plasma is used to synthesize gold nanoparticles (AuNPs) without using any reducing or capping agents. The effects of gold precursor concentration and of the discharge current on the particle formation process are analysed. Different precursor concentrations produce different nanoparticle size ranges: increasing the concentration leads to an increase in average diameter.

The morphology and optical properties of the synthesized AuNPs are characterized by transmission electron microscopy (TEM) and ultraviolet–visible spectroscopy. Plasma processing parameters affect the particle shape and size and the rate of the AuNP synthesis process. Particles of different shapes (e.g. spherical, triangular, hexagonal, pentagonal, etc) are synthesized in aqueous solutions. This is evident from the color of the solution as well as from the absorbance measurements.

Zeta potential measurements show a negative potential for all Au-NP colloids which increases (i.e. less negative) over time indicating that Au-NPs are initially stabilized electrostatically but that charges may be subsequently lost over time to the solution, at the walls of the containing vessel or saturated by atomic oxygen.

Reaction mechanisms for AuNP synthesis are discussed.

1. *Mariotti, D., Sankaran, R. M.* Microplasmas for nanomaterials synthesis. // J. Phys. D: Appl. Phys. - 2010. - 43 (32). - P. 1-21