Development of gas aggregation source and radial magnetron sputtering for the production of core@shell metallic nanoparticles

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1. Abstract

In recent years, novel magnetic, electronic and optical properties have been observed on nanoparticle systems made from different kind of materials. To improve the property of the nanoparticles, composite or core/shell are synthesized. The core/shell nanoparticles are used in the field of biotechnology as drug carrier, in electronics as semiconductor materials, and also in fuel-cell or chemical reaction as catalytic material. This work presents a new approach for the production of metallic core/shell nanoparticles by the combination of two physical techniques, the gas aggregation method and radial magnetron sputtering technique.

Samples of nanoparticles were produced by a generator of nanoparticle (NP-gun), built on one of the guns of a commercial magnetron sputtering system (AJA International) was used [1]. Typically we operate our sputtering system with the pressure in the main chamber of 5 mTorr. However, inside the NP gun we use an argon flux of 80 sccm, resulting in a pressure of about 760 mTorr. The atoms removed from the target are thermalized to the argon flux and condense to form the NPs. The particles are extracted from the NP gun aerodynamically and they flow directly to the substrate A schematic illustration of the NP-gun is showed in the figure 1.

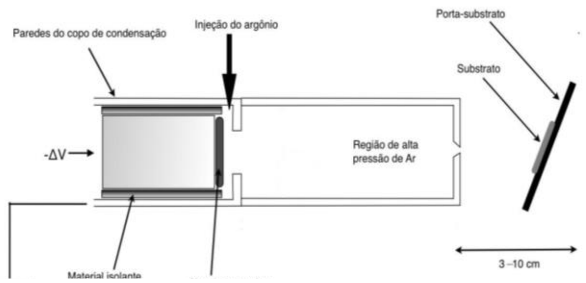

Fig. 1 *Schematic diagram of the NP-gun as an adaptation of a magnetron sputtering gun.*

To the production of the nanoparticles shell a radial magnetron sputtering gun (RMS-gun) was developed. The RMS is positioned on the top of the NP gun. The particles are extracted from the NP gun aerodynamically and then flow through the RMS-gun, where they are coated. This method permit the production of core-shell nanoparticles with specific dimensions and metallic materials for both, the core and the shell independently. The density of sputtered atoms produced by the RMS-gun is high enough for coating the nanoparticles with a uniform shell layer during its time-of-flying, inside the RMS-gun. This high deposition rate is obtained using very low power, around 5 W. A schematic illustration of the RMS-gun is presented in the figure 2.

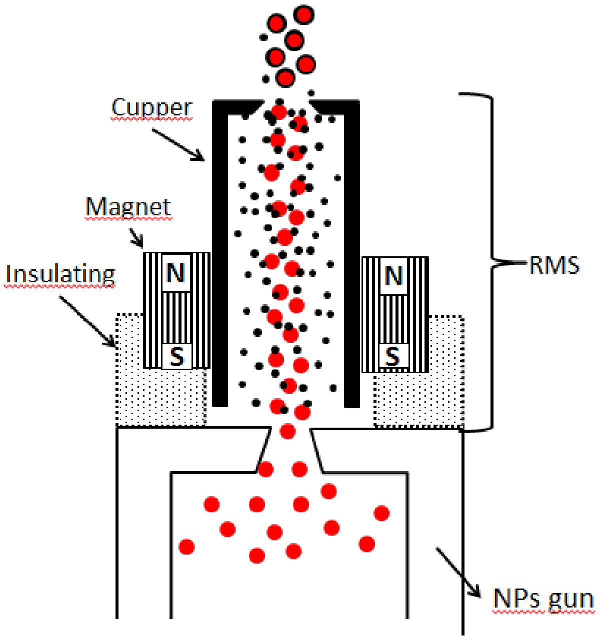

Fig. 2 *Schematic diagram of the RMS-gun positioned on the top of the NP-gun.*

The first kind of core-shell NPs produced, was magnetic NPs of Co, with a plasmonic Cu shell. The nanoparticles were characterized by XRD, VSM, RBS, Optical Spectroscopy, and STEM. The experimental results for this system will be presented.

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References

[1] G. T. Landi, S. A. Romero e A. D. Santos, *Rev.Sci. Instrum.*, vol. 81, p. 033908, 2010.