Synthesis, characterization and innovative coating of inorganic nanoparticles for hyperthermia and thermal ablation treatments

Novati B.[1], Giustra M.D.[1], Salvioni L. [1], Campopiano S.[2], Schena E.[3], Prosperi D.[1]

E-mail: b.novati2@campus.unimib.it
[1] Milano Bicocca University, Italy
[2] Naples Parthenope University, Italy
[3] Campus Bio-Medico University Hospital, Italy

Keywords: Nanoparticles, Multi-branched-Polymers, Hyperthermia, TATs, Photothermal-conversion.

Abstract:

In recent years, metallic nanoparticles have garnered significant interest in the biomedical field, particularly as optimal nanotechnologies to support and enhance the efficiency of Oncologic Hyperthermia and Thermal Ablation treatments (TATs).
Based on their physicochemical properties, once accumulated at the tumor site, metallic nanoparticles can be activated by external energy sources such as lasers or alternating magnetic fields to generate heat in a controlled manner.
The research was focused on the optimization of experimental parameters related to the synthesis of Silver/Gold alloy and Gold nanoparticles with cubic cage and rod morphologies, also known as "Nanocages" and "Nanorods," respectively, for the modulation of size and optical properties.
Following this, the nanoparticle coating surfactant was replaced with an innovative multi-branched polymer functionalized on the surface, capable of improving colloidal stability and reducing toxicity in a biological environment, assessed through the MTS assay.
Subsequently, the photothermal response of colloidal nanoparticles was evaluated by measuring the temperature variation resulting from the excitation of surface plasmons through 1064 nm laser radiation (Nd:Yag Laser).
This analysis was performed using a Phantom, in which nanoparticles were dispersed at a known concentration and excited by the laser radiation. The Phantom is a sol-gel prepared with Agarose at different concentrations and characterized by specific mechanical properties for the simulation of the tumor environment.
The measurement of the photothermal response of colloidal nanoparticles with different optical properties resulted in different temperature changes, allowing the assessment of the influence of UV-Vis absorption, composition and morphology on the efficiency of radiation-to-heat conversion.
Finally, this research opens new perspectives for the treatment of solid tumors through hyperthermia, laying the groundwork for future advances in personalized medicine based on the use of nanotechnologies.