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Hybrid metal-polymer nanoparticles as promising radiosensitizers for cancer treatment

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Nanotechnologies are being widely studied for medical applications, both diagnosis and treatment. They have already shown great promise, especially to treat cancer through various strategies such as chemotherapy, photothermal therapy or radiation therapies. High-Z elements nanoparticles are of particular interest for the latter, considering their ability to amplify the damaging effects of both photon and ion radiations: gold, platinum and gadolinium are amongst the most investigated elements. [1][2]

A well-controlled synthesis is key to obtain stable and scalable nano-objects. Here, various polymers were grafted onto metallic nanoparticles to improve stability and biocompatibility and to facilitate subsequent functionalization. Advanced methods of characterization attested to the robustness and reproducibility of the synthesis procedure. Moreover, promising results were obtained regarding the radioenhancing properties of these hybrid nanocompounds.

Polymers mainly synthesized via controlled radical polymerization were grafted onto gold and platinum nanoparticles by a “grafting to” or “grafting from” method. Subsequent grafting of a chemotherapy drug onto the polymer corona was also successfully carried out.

The resulting nano-objects were fully characterized by thermogravimetric analysis, transmission electronic microscopy and small-angle x-ray scattering. Small-angle neutron scattering was also performed, taking advantage of possible contrast matching. The impact of various radiation doses on the nanoparticles structure was studied. Finally, radiosensitizing effects were investigated through in vitro tests.

Under irradiation, uncoupling and cleavage of polymer chains were demonstrated, leading to an overall size reduction of the hybrid nano-objects. The location of target sites during irradiation was determined and helped to better understand the underlying mechanism of the radiosensitization assessed by the in vitro results.

The synthesized nano-objects have therefore shown great potential to enhance radiation cancer treatment. Their stability and controlled surface chemistry will allow to develop multiple strategies to further improve their radiosensitizing effect and in vitro behavior. In vivo tests are currently under study, as well as experiments regarding radioenhancement for proton therapy.

[1] T. Schlathöler et al., Int. J. Nanomedicine, vol. 11, p. 1549 1556, avr. 2016.

[2] K. Haume et al., Cancer Nanotechnol., vol. 7, no 1, p. 8, nov. 2016.