Nanocasting template synthesis of porous persistent luminescent nanoparticles for PDT

Mathilde Ménard[1], Christophe Dorandeu[1], Sofia Dominguez-Gil[1], Nicolas Donzel[1], Jean-Olivier Durand[1], Frédérique Cunin[1], Aurélie Bessière[1]

[1]Institut Charles Gerhardt Montpellier, UMR 5253, CNRS, Montpellier, France

mathilde.menard@umontpellier.fr
aurelie.bessiere@umontpellier.fr

Persistent luminescent materials (PERL) possess the unique optical property to have a long-lasting afterglow that persists after the cessation of excitation. They are mostly made of bulk materials or micrometric powders synthesized by solid-state chemistry at high temperature. However, their nanoscale counterparts need softer chemistry synthesis pathways, like hydrothermal syntheses, leading frequently to a decrease in their PERL efficiency. Thus a post-synthesis annealing treatment is often necessary to increase their PERL properties but it has the major disadvantage to induce sintering effects. Therefore, we propose to use mesoporous silica nanoparticles as sacrificial hard-nano-template to synthesize porous PERL nanoparticles at high temperature. We choose $ZnGa_2O_4:Cr^{3+}$ as PERL material since it emits at 700 nm (red emission) [1] and it showed an exceptional potential as nano-probe for biomedical optical imaging [2]. However, the actual synthesis methods do not lead to porous $ZnGa_2O_4:Cr^{3+}$ nanoparticles thus limiting their biomedical applications. Indeed, additional synthesis steps are necessary to add porosity to the material like for example the addition of a porous silica shell. Therefore, we developed the synthesis of porous $ZnGa_2O_4:Cr^{3+}$ nanoparticles through a nanocasting synthesis strategy. First, the PERL precursors were impregnated into the mesoporosity of silica nanoparticles and then a thermal treatment was performed to crystalize the PERL material into the pores. Finally, the silica was dissolved to free the porosity of the as-obtained nano-PERL that can be then used for example for photosensitizers loading to perform deep PDT by persistent luminescence [3].

References

[1] A. Bessière, et al., Optics Express, 19, 11, (2011), p 10131-10137
[2] T. Maldiney, et al., Nature Materials, 13, 4, (2014), p 418-426
[3] A. Bessière, et al., Nanophotonics, 10, 12 (2021), pp.2999-3029.

Figures

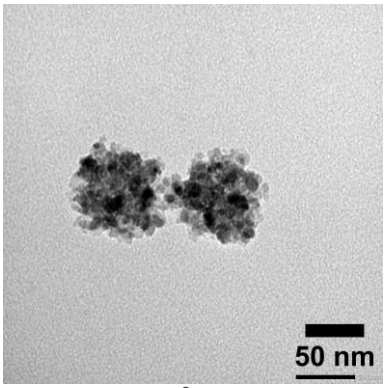

Figure 1. PERL $ZnGa_2O_4:Cr^{3+}$ nanoparticles synthesized via nanocasting