Continuous Synthesis of $In_xGa_{1-x}N$ ($0 \leq x \leq 1$) Luminescent Nanoparticles via Supercritical Fluids

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Supercritical fluids exhibit unique properties which can be harnessed in order to produce nanomaterials with unique properties. Especially, high pressure and temperature conditions give access to more crystalline materials, and the density fluctuations allow ultra-fast nucleation which translates into small nanoparticles. On the other hand, a continuous route enabled by microfluidic reactors gives us a better grasp over synthesis parameters such as temperature and residence time, leading to further control of the nanomaterial morphological properties, and allows the addition of different reactors in series in order to control the particle structure and surface properties.

Such control is necessary for the production of luminescent semiconductor nanocrystals, also known as quantum dots, since their luminescence properties are highly dependent on their shape, size, structure, composition and surface properties, among other factors. These materials have been attracting attention for their ability to produce highly monochromatic light at a wavelength controllable solely by the particle size and with excellent luminance and quantum yields, while still being solution-processable, as compared to organic counterparts which also suffer from a lack of stability and a low lifetime.

Indium-gallium nitride ($In_xGa_{1-x}N$ - $0 \leq x \leq 1$) is a particularly attractive material since its bandgap can be tailored not only by the size, but by the indium/gallium composition ratio as well: the emission wavelength can then be set to a desired value between 1700 nm (InN) and 330 nm (GaN), which represents the totality of the visible spectrum. Moreover it represents a biocompatible alternative to widely studied cadmium-based quantum dots, and would therefore open the way towards a wide array of applications in the medical field, but also in IoT (Internet of Things) and the Industry of the Future (displays, sensors). Although its synthesis remains a challenge, the continuous supercritical route has already proven to yield particles with excellent crystallinity and homogeneous indium/gallium repartition and is thus promising for the synthesis of high quality indium-gallium nitride, as opposed to batch-synthesized particles which exhibit strong segregation between both metals.