Nanocrystals as local sensor of temperature

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Nanocatalysis (the use of well characterized NPs as catalyst) has been receiving recently an increasing attention and has emerged as a domain at the border between homogeneous and heterogeneous catalysis.[i,ii] An additionnal input compared to the classical approach, is the use of the physical properties of the catalytic NPs for self-heating (magnetic or plasmonic properties) during the catalysis process, whether homogeneous, in solution, or heterogeneous after deposition onto a support. Temperature measurement near the surface of the catalyst is mandatory since the catalytic reactions display precise temperature ranges outside which they can follow alternative pathways; it is however not a trivial objective, especially above 200°C. The pertinent information is the surface temperature of the particles since there will be a huge gradient of temperature between the heated particles and the "cold" environment. Thermometric probes have been described at low temperatures with fluorophores as well as with quantum dots – QDs.[iii] However, using phosphors to determine high temperatures under harsh experimental conditions remains largely unexplored and highly challenging [iv]. At the nanoscale, QDs optical properties offer a rare opportunity to build an innovative complex nano-object integrating heating capacities, catalytic ability and thermal reporting property.

Thus, the temperature-dependent emission of different NCs have been investigated in this purpose. Different parameters such as the peak wavelength, the intensity, the area of emission and the full width at half maximum were completely characterized as a function of temperature. The range of temperature studied goes from room temperature to 500°C (solution and/or solid state). NCs of Cd_3P_2, InP and CdSe were synthesized and investigated with and without shell (ZnS for InP and Cd_3P_2, CdS for CdSe). The comparison between the different NCs and the presence of a shell are discussed.

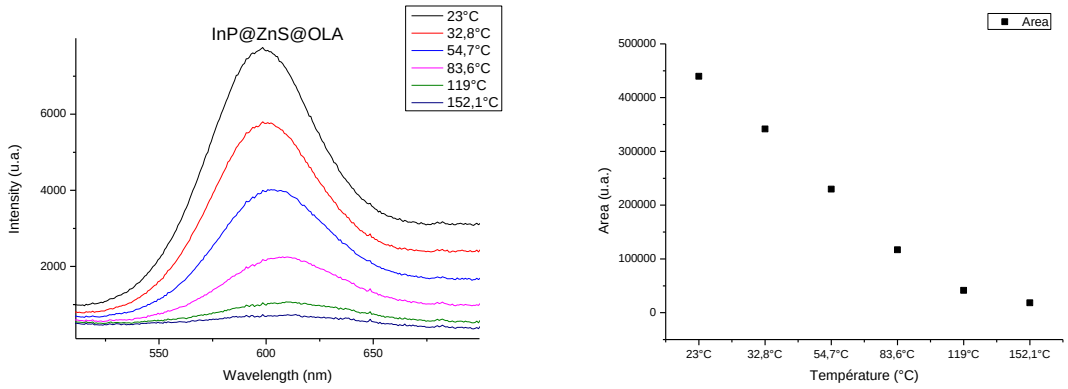

Fig. 1 Photoluminescence intensity of InP@ZnS with oleylamine as stabiliser in solution in octadecene at different temperatures.

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i G.A. Somorjai etal.J.Am.Chem.Soc. 131, 1658 (2009); G.A. Somorjai, et al. Top.Catal. 53, 311 (2010); Y. Zhang, et al. J. Am.Chem.Soc., 130, 5868 (2008)

ii L. Feng, et al. Nano Res. 4, 61 (2011); b) C. Tsung, et al. J. Am. Chem. Soc., 131, 5816 (2009)

iii D. Jaque, D. et al Nanoscale 4, 4301 (2012); Brites, C. D. S. et al. Nanoscale 4, 4799, (2012).

iv X.D. Wang, et al. 42, 7834 (2013)