High-pressure study of YVO_4 nanoboxes

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YVO_4 is a very interesting material which finds an extensive use in material science and technology due to its outstanding optical properties. YVO_4:Nd^{3+} is used in industrial diode pumped solid state lasers [1]. The improvement of luminescence properties in nanosized and pressure-treated materials has opened an enormous working field in phosphors [2] and the study of rare-earth ions in the nano-environment of ABO_4 compounds is important for the development of phosphors with enhanced luminescence efficiency by combining the promising optical properties of rare-earth ions and nanoparticles [3,4].

Bulk YVO_4 crystallizes in the zircon structure (space group S.G. #141) and it undergoes two pressure-induced phase transitions: a first one towards the scheelite structure (S.G. #81) above 7.5 GPa [5,6] and a second one towards the fergusonite structure (S.G. #15) above 23 GPa [7]. Knowing the phase transitions in nanocrystals could give a better insight into the relation between compositional, structural and optical properties in order to design better phosphors or even provide novel nanocrystal phases which could be retained in metastable way, like diamond, at ambient conditions with enhanced optical properties with respect to parent materials.

We have synthesized Eu-doped YVO_4 nanoboxes with zircon structure and 25 ± 5 nm lateral size. Nanoboxes have been characterized by X-ray diffraction, Raman scattering, and photoluminescence under pressure up to 18 GPa. The pressure behaviour of nanocrystals has been compared to that of bulk material [2,5-7]. We have found that the zircon-to-scheelite phase transition occurs at a much higher pressure in nanocrystals as compared to the bulk. Additionally, a possible intermediate monoclinic phase between zircon and scheelite could be present in nanocrystals unlike in the bulk as recently suggested to occur in zircon-type chromates [8].

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