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Emission properties of wide bandgap nanostructures

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Wide bandgap nanostructured materials have been a topic of intense research worldwide, due to the possibility to tailor their properties for a myriad of near-future applications, including electronics, optoelectronics, and sensing. In the optoelectronics field, nitride- and oxide-based families have already demonstrated their potentialities as multifunctional materials able to manipulate the light outcome. For such purposes, engineering nanomaterials through composites and intentionally doped hosts are especially attractive and provide new insights and opportunities for light emitters with enhanced functionalities. However, the ability to realize emitters at the nanoscale demands a deeper understanding of the recombination processes that take place in the nanomaterials.

The investigation of the luminescence processes, including excitonic recombinations or defect-related transitions of intrinsic/extrinsic nature from bulk and surface/interface semiconductor nanostructures, provide a reliable approach to demonstrate the nanomaterials' suitability as an emitter. Furthermore, advanced spectroscopic tools such as Raman spectroscopy, absorption, photoluminescence (PL) under steady state and transient (TRPL) conditions, and PL excitation (PLE) are proper optical techniques to assess the nanomaterials' optical response and to investigate their recombination and energy transfer models. An adequate knowledge of these processes is crucial for the optimisation of their functionalities towards optoelectronics and bioimaging applications.

In this talk, the main focus is given to the optical characterisation of wide bandgap nanostructures and composites. Several case studies will be discussed including undoped and intentionally doped nitrides, oxides and composite nanomaterials grown/synthesised by distinct approaches. The unique spectroscopic characteristics of the studied systems, namely the response of the optically active centres to the excitation energy, excitation density and temperature dependences enable to establish recombination models, providing a comprehensive analysis of the possible nanomaterial-based emitters.

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