Multifunctional rare-earth and transition metal-ion doped materials and devices

Jianhua Hao[1,2]

[1]Department of Applied Physics and Materials Research Center
The Hong Kong Polytechnic University
Hong Kong, CHINA
[2] The Hong Kong Polytechnic University Shenzhen Research Institute
Shenzhen 518057, CHINA
Email: jh.hao@polyu.edu.hk

Metal (rare-earth, transition metal, etc.)-ion doped compounds are commonly used in the area of optical materials and devices. Optical and luminescent characteristics can be controlled by the host and metal-ion dopants of this class of phosphors. With the successful applications of metal-ion doped luminescent materials in photonic and biomedical areas, considerable efforts are being directed toward the realization of multifunction in such luminescent materials. A possible contribution may be delivered by metal-ion doped phosphors, allowing the coupling of multi-fields to photon emission. In my talk, I will present recent results regarding to multifunctionalization and applications of biomedical imaging and photonics based on various metal ion-doped material systems, which have recently been done in my group. A multifunctional nanoprobe for tri-modal bioimaging of fluorescence, computed X-ray tomography, and magnetic application is showed using single-phase lanthanide-doped nanomaterial. On the other hand, tuning of spectroscopy and luminescence are highly desirable for understanding the physical processes of energy transition and widespread applications. Modification of photoluminescence in the phopshors can normally be achieved through conventional chemical method in an irreversible and *ex situ* process, which is unlikely to know the kinetic process. Here we report on the tuning of spectroscopy and luminescence in real-time and *in situ* manners by physical methods, such as electric-field and strain. Raman and luminescent spectra of solids under electric-field and strain are characterized. Simultaneous dual-mode light and ultrasound emissions are observed in transition metal-ion doped thin-film/piezoelectric device. In this study**,** typical materials systems may range from metal-activators (rare-earth, transition metal ions) doped ferroelectric insulators, wurtzite-type semiconductors to 2D atomic layers. These materials and devices can show tunable spectroscopy and luminescence under the control of external dc/ac electric-field and strain. Our results will be helpful for the further investigation of energy transition process and widespread multifunctional applications because of additional degree of freedom in the design of optical materials and devices. The works are supported by the grants from RGC GRF (PolyU5002/12P) and NSFC (No. 51272218).

References:

[1] Y. Zhang and J.H. Hao, *J. Mater. Chem. C*, 1, 5607 (2013) (Feature Review Article).
[2] H.-T. Wong, M.-K. Tsang, C.-F. Chan, K.-L. Wong, B. Fei, and J.H. Hao, *Nanoscale*, 5, 3465 (2013).
[3] Beibei Xu, Jianhua Hao, Shifeng Zhou, Jianrong Qiu, *Optics Express* 21, 18532 (2013).
[4] Wenjing Jie, Yeung Yu Hui, Yang Zhang, Shu Ping Lau, Jianhua Hao, *Appl. Phys. Lett.,* 102, 223112 (2013).
[5] S. J. Zeng, M.-K. Tsang, C.-F. Chan, K.-L. Wong, and J. H. Hao**,** *Biomaterials*, 33, 9232 (2012).
[6] Z.-L. Wang, J. H. Hao, H. L. W. Chan, W.-T. Wong, and K.-L. Wong, *Small* 8, 1863 (2012).
[7] S. J. Zeng, M.-K. Tsang, C.-F. Chan, K.-L. Wong, B. Fei and J. H. Hao, *Nanoscale* 4, 5118 (2012).
[8] Y. Zhang, G. Y. Gao, H. L. W. Chan, J. Y. Dai, Y. Wang, and J. H. Hao, *Adv. Mater.*, 24, 1729 (2012).