A General Route to Efficient Near-Infrared Emission of Optically Active Nanozeolites

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Here we report on a facile and novel strategy to realize strong, air-stable, long-lived, near-infrared (NIR) photoluminescence (PL) from rare-earth ions and bismuth compounds embedded zeolites. This method consists of a simple ion-exchange process and subsequent high-temperature annealing under a controlled atmospheric condition. We demonstrate that `blocking` the small pores of zeolites by using bismuth compounds with low melting points is an excellent approach to realize efficient NIR emission from active centres [1] (**Figure 1**). Moreover, we found that bismuth not only acts as blocks of selectively closing down the `in-out windows` of water molecules, but as ultrabroad NIR luminescence centres if we annealed the samples in an inert atmosphere. The advantages of this finding can be summarized as follows: (i) the PL from these annealed zeolites is strong and air-stable; (ii) the quantum efficiencies of NIR emission are high in these nanomaterials; (iii) the PL displays spectral tunability by tailoring preparation parameters; (IV) The broad NIR PL with a FWHM more than 160 nm covers the whole telecommunication windows, which is much broader than those of rare-earth ions. Most importantly, herein we demonstrate that even in samples containing a large amount of water, it is possible to realize efficient NIR emission if we can effectively separate active ions from coordinated water. Owing to the peculiar optical properties of these activated zeolites and mature zeolites assembly techniques developed, we believe that it is promising for their wide applications as active media of broadly tunable micro or nano optical sources and devices.

References:

[1] H-T. Sun, T. Hasegawa, M. Fujii, F. Shimaoka, Z. Bai, M. Mizuhata, S. Hayashi, S. Deki, Applied Physics Letters, 94 (2009) 141106.

Figure 1: Schematic illustration of the structure of rare-earth and bismuth ions codoped zeolites annealed at high temperatures.