Light-Emitting Copper Nanoclusters: Synthesis, Optical Studies, and Use in Light Emitting Devices

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Metal nanoclusters (NCs) have attracted a great deal of attention, as their properties deviate from those of bulk metals and, nanoparticles, while rather resembling molecular compounds.[1] Last decade has evidenced significant development of the synthesis and application of metal NCs, mainly Au and Ag. Cu is a relatively abundant, inexpensive chemical element, which is readily available from commercial sources. The use of Cu NCs has been limited so far by the relatively low photoluminescence (PL) quantum yield (QY), which is around 10% and poor stability against oxidation.[2] We will introduce our recent strategies to improve the PL QY and stability of Cu NCs, including surface ligands (thiols containing ligands and citrate) treatment [2] and aggregation-induced emission enhancement [3].

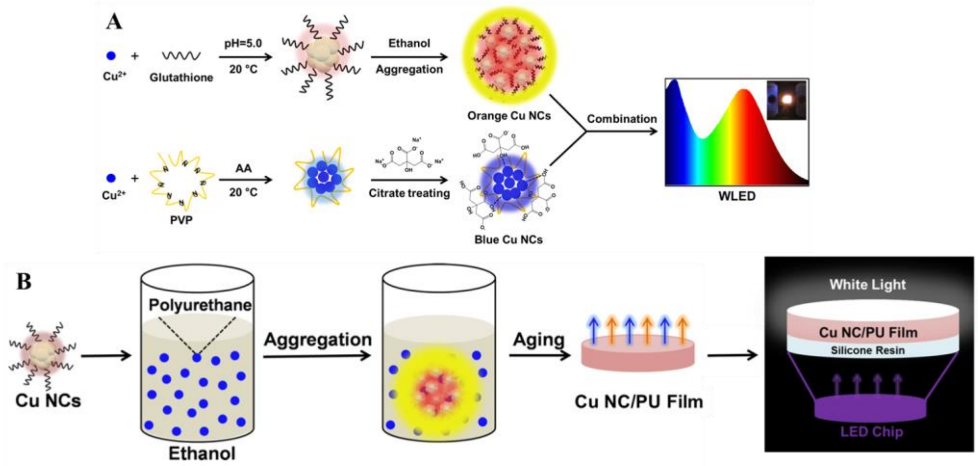

Fig. 1 (A) Schematic illustration for the fabrication of white LEDs based on the blue and orange emitting Cu NCs. (B) Schematic illustration for the synthesis of dual emission Cu NC/PU films and their use for remote LEDs.

Light-emitting devices (LEDs) have been widely used in displays, automotive headlamps, and traffic signals, with white LEDs (WLEDs) increasingly considered as a useful alternative to replace incandescent light bulbs for general lighting.[4] Most of the present-day down-conversion white light-emitting devices (WLEDs) utilize rare-earth elements, which are expensive and facing the problem of shortage in supply. We employed Cu NCs as light emitting materials for application in UV-light pumped light emitting diodes (LEDs),[2] all-copper nanoclusters based white LEDs,[3] and remote white LEDs based on luminescent films of aggregated copper nanoclusters in carboxylated polyurethane[5] (Figure 1).

[1] Z. Wu, et al, *J. Am. Chem. Soc*. **2015**, *137*, 12906.
[2] Z. Wang, et al, *Nanoscale* **2016**, *8*, 7197.
[3] Z. Wang, et al, *Adv. Sci.,* **2016**, 1600182.
[4] Z. Zhuang, et al, *Adv. Funct. Mater*. **2016**, *26*, 36.
[5] Z. Wang, et al, *ACS Appl. Mater. Interfaces*, **2016**, *8*, 33993.