Efficient and tuneable photoluminescent boehmite hybrid nanoplates lacking metal activator centres for single-phase white LEDs

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White light-emitting diodes (WLEDs) are candidates to revolutionize the lighting industry towards energy efficient and environmental friendly lighting and displays. The most common WLED is a combination of a blue LED chip and YAG:Ce^{3+} yellow-emitting phosphor. The main disadvantages of such WLED are the poor colour-rendering index (CRI) and the low stability of the correlated colour temperature (CCT) that varies with the drive voltage and the phosphor coating thickness. Also, the presence of critical elements (e.g. lanthanide ions) whose scarcity and supply disruption is a noticeable concern is another drawback. Ultraviolet-pumped WLEDs gained considerable attention as an alternative due to easier manufacture process, low colour variation as a function of the forward-bias current and superior temperature stability. Moreover, as the human eyes are insensitive to ultraviolet radiation, the white colour is independent of the pumping LED and thickness of the phosphor layer.

From the materials science point of view, the main challenge is to develop a new ultraviolet down-converting metal activator-free compound with high emission quantum yield, CRI>80, and thermal stability. We developed a simple route to design high-efficient WLEDs by combining a commercial ultraviolet LED chip (InGaAsN, 390 nm) with few-nm thick boehmite nanoplates capped with in situ-formed benzoate ligands.1 The advantage of the boehmite hybrid phosphors lies in the fact that they are made of non-toxic, abundant and low-cost materials. Unusually high quantum yields (up to 58%) result from a synergic energy transfer between the boehmite-related states and the triplet states of the benzoate ligands. The produced WLED has CIE coordinates, CRI and CCT values of (0.32, 0.33), 85.5 and 6,111 K, respectively; overwhelming state-of-the-art single-phase WLEDs phosphors.