nature COMMUNICATIONS

ARTICLE

Received 29 Jan 2014 | Accepted 6 Jun 2014 | Published 8 Jul 2014

DOI: 10.1038/ncomms5312

Highly efficient non-rare-earth red emitting phosphor for warm white light-emitting diodes

Haomiao Zhu[1], Chun Che Lin[2], Wenqin Luo[1], Situan Shu[1], Zhuguang Liu[1], Yongsheng Liu[1], Jintao Kong[1], En Ma[1], Yongge Cao[1], Ru-Shi Liu[2] & Xueyuan Chen[1]

Mn^{4+}-activated fluoride compounds, as an alternative to commercial (oxy)nitride phosphors, are emerging as a new class of non-rare-earth red phosphors for high-efficacy warm white LEDs. Currently, it remains a challenge to synthesize these phosphors with high photoluminescence quantum yields through a convenient chemical route. Herein we propose a general but convenient strategy based on efficient cation exchange reaction, which had been originally regarded only effective in synthesizing nano-sized materials before, for the synthesis of Mn^{4+}-activated fluoride microcrystals such as K_2TiF_6, K_2SiF_6, $NaGdF_4$ and $NaYF_4$. Particularly we achieve a photoluminescence quantum yield as high as 98% for K_2TiF_6:Mn^{4+}. By employing it as red phosphor, we fabricate a high-performance white LED with low correlated colour temperature (3,556 K), high-colour-rendering index ($R_a = 81$) and luminous efficacy of 116 lm W^{-1}. These findings show great promise of K_2TiF_6:Mn^{4+} as a commercial red phosphor in warm white LEDs, and open up new avenues for the exploration of novel non-rare-earth red emitting phosphors.

[1] Key Laboratory of Optoelectronic Materials Chemistry and Physics, Key Laboratory of Design and Assembly of Functional Nanostructures, Fujian Institute of Research on the Structure of Matter, Chinese Academy of Sciences, Fuzhou, Fujian 350002, China. [2] Department of Chemistry, National Taiwan University, Taipei 106, Taiwan. Correspondence and requests for materials should be addressed to X.C. (email: xchen@fjirsm.ac.cn) or to R.S.L. (email: rsliu@ntu.edu.tw).