



### 材料合成及性能

#### 单一基质白色荧光粉Ca<sub>9</sub>Al(PO<sub>4</sub>)<sub>7</sub>:Ce<sup>3+</sup>,Dy<sup>3+</sup>的制备与发光性能

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摘要：采用高温固相法在还原气氛下合成了Ca<sub>9</sub>(1-x-y)Al(PO<sub>4</sub>)<sub>7</sub>:xCe<sup>3+</sup>,yDy<sup>3+</sup>荧光材料,并对其发光特性进行了研究。XRD测试表明所合成样品为纯相Ca<sub>9</sub>Al(PO<sub>4</sub>)<sub>7</sub>晶体。在268 nm紫外光激发下,Ca<sub>9</sub>Al(PO<sub>4</sub>)<sub>7</sub>:Ce<sup>3+</sup>呈现峰值位于363 nm的宽带发射。在350 nm近紫外光激发下,Ca<sub>9</sub>Al(PO<sub>4</sub>)<sub>7</sub>:Dy<sup>3+</sup>发射光谱为窄带谱,主峰分别位于483 nm和574 nm,对应Dy<sup>3+</sup>的<sup>4</sup>F<sub>9/2</sub>→<sup>6</sup>H<sub>15/2</sub>和<sup>4</sup>F<sub>9/2</sub>→<sup>6</sup>H<sub>13/2</sub>特征跃迁,呈黄白光发射。荧光光谱表明:Ce<sup>3+</sup>,Dy<sup>3+</sup>共掺之后,Ce<sup>3+</sup>不仅对Dy<sup>3+</sup>的特征发射有明显的敏化作用,而且通过调节Ce<sup>3+</sup>和Dy<sup>3+</sup>的掺杂比例,可实现从黄白光到白光的颜色变化。研究发现:Ca<sub>9</sub>(1-x-y)Al(PO<sub>4</sub>)<sub>7</sub>:xCe<sup>3+</sup>,yDy<sup>3+</sup>样品中,掺杂离子的最佳摩尔分数为x=0.02,y=0.02,此时色坐标为(0.306, 0.313)。

关键词：Ca<sub>9</sub>Al(PO<sub>4</sub>)<sub>7</sub>:Ce<sup>3+</sup>,Dy<sup>3+</sup> 白色荧光粉 发光 色坐标

#### Synthesis and Luminescent Properties of The Single White Emitting Phosphor Ca<sub>9</sub>Al(PO<sub>4</sub>)<sub>7</sub>:Ce<sup>3+</sup>,Dy<sup>3+</sup>

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Abstract: Phosphors Ca<sub>9</sub>(1-x-y)Al(PO<sub>4</sub>)<sub>7</sub>:xCe<sup>3+</sup>,yDy<sup>3+</sup> were synthesized by solid-state reaction method at high temperature under a reducing atmosphere of CO, and the luminescent properties of the phosphors were investigated. The X-ray diffraction patterns (XRD) show that a pure phase of Ca<sub>9</sub>Al(PO<sub>4</sub>)<sub>7</sub> phosphor has been obtained after calcined at 1 200°C. Under 268 nm excitation, the Ca<sub>9</sub>Al(PO<sub>4</sub>)<sub>7</sub>:Ce<sup>3+</sup> sample exhibits a broad emission band centered at 363 nm. The emission spectrum of Ca<sub>9</sub>Al(PO<sub>4</sub>)<sub>7</sub>:Dy<sup>3+</sup> sample under 350 nm excitation shows two characteristic emissions of Dy<sup>3+</sup> located at 483 nm and 574 nm, corresponding with <sup>4</sup>F<sub>9/2</sub>→<sup>6</sup>H<sub>15/2</sub> and <sup>4</sup>F<sub>9/2</sub>→<sup>6</sup>H<sub>13/2</sub> transition, respectively. According to the fluorescence spectra, the characteristic emissions of Dy<sup>3+</sup> are significantly sensitized by Ce<sup>3+</sup> when the Ca<sub>9</sub>Al(PO<sub>4</sub>)<sub>7</sub> samples are co-doped with Ce<sup>3+</sup> and Dy<sup>3+</sup>. Adjusting the concentration of Ce<sup>3+</sup> and Dy<sup>3+</sup>, the color of the phosphors can change from yellowish-white to white. The results indicate that the optimal mole fractions of Ce<sup>3+</sup> and Dy<sup>3+</sup> in Ca<sub>9</sub>(1-x-y)Al(PO<sub>4</sub>)<sub>7</sub>:xCe<sup>3+</sup>,yDy<sup>3+</sup> are x=0.02 and y=0.02, and the chromaticity coordinate is (0.306, 0.313).

Keywords: Ca<sub>9</sub>Al(PO<sub>4</sub>)<sub>7</sub>:Ce<sup>3+</sup>,Dy<sup>3+</sup> white emitting phosphor luminescence color coordinate

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#### 参考文献:

[1] Yang T L, Xia W W, Yu H Z, *et al.* Preparation and optical properties of the orthorhombic Gd<sub>2</sub>(MoO<sub>4</sub>)<sub>3</sub>:Dy<sup>3+</sup> phosphor for white LEDs [J]. *Chin. J. Lumin.* (发光学报), 2012, 33(9):929-933 (in Chinese). [2] Bándi V R, Nien Y T, Chen I G. Enhancement of white light emission from novel Ca<sub>3</sub>Y<sub>2</sub>Si<sub>3</sub>O<sub>12</sub>:Dy<sup>3+</sup> phosphors with Ce<sup>3+</sup> ion codoping [J]. *Appl. Phys. Lett.*, 2010, 108(2):023111-1-4. [3] Li P L, Wang Y, Guo Q L. Research progress in single host white light emitting phosphor for white LEDs [J]. *Chin. Sci. Bull.* (科学通报), 2011, 56(7):488-503 (in Chinese). [4] Sun X Y, Li C J, He X G, *et al.* Effect of MgO doped concentration on luminescence properties in Sr<sub>2</sub>SiO<sub>4</sub>:Eu<sup>2+</sup> phosphor [J]. *Chin. J. Lumin.* (发光学报), 2012, 33(4):389-393 (in Chinese). [5] Yang Z P, Liu Y F, Wang L W, *et al.* Luminescence properties of the single white emitting phosphor Eu<sup>2+</sup>, Mn<sup>2+</sup> co-doped Ca<sub>2</sub>SiO<sub>3</sub>Cl<sub>2</sub> [J]. *Acta Physica Sinica* (物理学报), 2007, 56(4):546-550 (in Chinese). [6] Yahia B H, Gaudin E, Darriet

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