UDC 66

STUDY ON PROPERTIES OF CS2NABICL6:X%MN2+ DOUBLE PEROVSKITE LUMINESCENT MATERIALS

Xiaolong Jing, PhD student,Inorganic Chemistry, 2021
Lingtao Sun, PhD student, Inorganic Chemistry, 2021
Rong Jin, PhD student Inorganic Chemistry, 2021
Junjun Li, PhD student Inorganic Chemistry, 2021
Qing Chen, PhD student mining mechanics,2021
Tatyana Grigorievna Cherkasova, Professor, Academician,
president of Institute of Chemical and Gas and Oil Technologies, T.F. Gorbachev
Kuzbass State Technical University

1. Introduction

In recent years, halide lead based perovskite has attracted wide attention due to its advantages such as narrow band emission, high quantum efficiency, high carrier mobility and adjustable emission wavelength, and has become the most potential material in the optical field[1-6]. LED devices prepared by this material have higher color purity, wider color gamut value and larger color rendering index, so they have a wide range of applications in lighting and display fields[7-8]. However, there is heavy metal Pb in this material, which is very harmful to human body. After Pb enters the body, it will cause damage to the digestive system, nervous system and endocrine system of the body, which seriously limits the practical application of this material. This paper attempts to prepare lead-free halide perovskite by hydrothermal method to find non-toxic and stable perovskite luminescent materials.

2. Experiment

Cs2NaBiCl6:x%Mn2+ microcrystals were prepared by hydrothermal method. Weigh 2 mmol CsCl, 1 mmol NaCl, and 1 mmol BiCl3 in the polytetrafluoroethylene liner reactor, then use a pipette gun to transfer 12 mL concentrated HCl into the liner reactor, cover the liner with a lid, put it into a high-pressure reactor and tighten it. Then the high-pressure reactor was placed in an electronic constant temperature drying oven, and the temperature was raised to 180 ℃ at 3 ℃/min. The reactor was kept for 12 h, and then slowly cooled to room temperature within 48 h. After the solution was cooled to room temperature, the samples in the reactor were extracted and cleaned for several times. Finally, the samples were put into a constant temperature drying oven and dried at 70 ℃ for 6 h. The samples were successfully obtained and collected.

The data of all samples were collected by TD-3500 X-ray diffractometer (XRD). The measurement parameters were 20 mA, 30 kV, and the measurement range was 10°-70°. In order to confirm the phase structure of the sample, it is analyzed by comparing with the standard PDF card of the substance.

The emission (PL) spectra and excitation (PLE) spectra of the samples were measured by Hitachi F-7000 fluorescence spectrophotometer.

3.Results and discussion

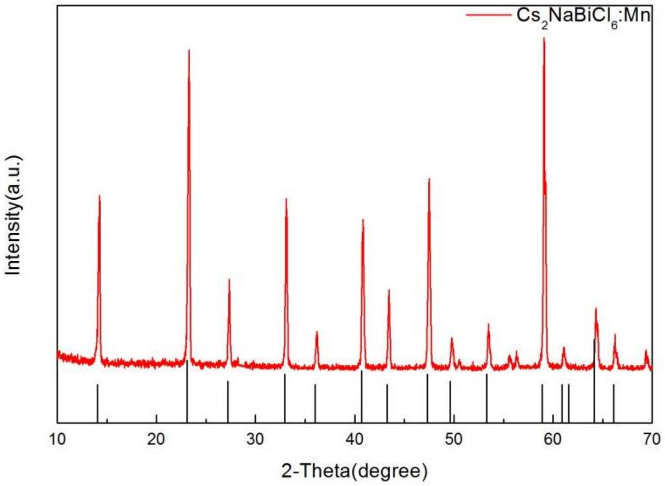
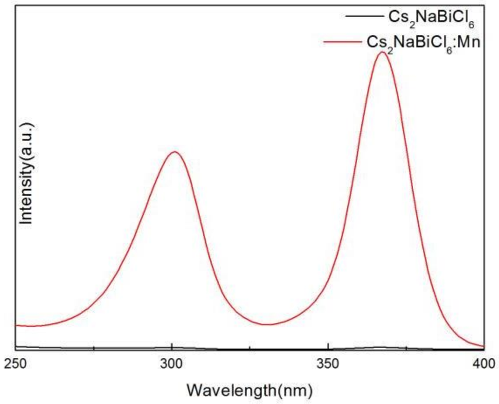


Figure 1 XRD pattern of $Cs_2NaBiCl_6$:x%Mn^{2+}

X-ray diffractometer was used for qualitative analysis of the doped Cs2NaBiCl6:x%Mn2+ sample, and the results were shown in Figure 1. The results show that the diffraction peaks of all samples are in good agreement with the standard crystal structure map, indicating that the synthesized Cs2NaBiCl6:x%Mn2+ is pure phase, no impurities are generated, and the doping of Mn2+ does not change its original crystal structure.



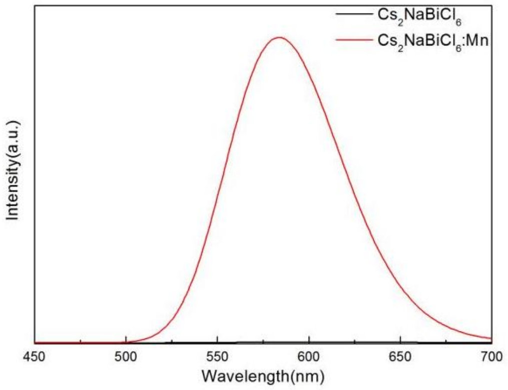


FIG. 2 Excitation and emission spectra of $Cs_2NaBiCl_6$ before and after doping

Fluorescence spectrophotometer was used to measure the excitation spectra and emission spectra of the samples. The results show that the undoped sample has two excitation bands at 300nm and 367nm, but the intensity of the excitation bands is low. After the addition of Mn^{2+}, the intensity of the excitation band at 300nm and 367nm is obviously enhanced. After doping, all the samples showed yellow emission band with about 584nm as the center. The wavelength of emission before and after doping is similar to that of undoped sample.

Based on the above research, $Cs_2NaBiCl_6$:x%Mn^{2+} broadband yellow phosphors were prepared by hydrothermal method with $Cs_2NaBiCl_6$ matrix as the center, which showed high emission intensity and demonstrated its application potential as a new luminescent material. However, it is still necessary to further study the luminescent properties and stability of $Cs_2NaBiCl_6$ under different doping elements, so as to explore its application potential.

Reference

[1]Jiang M C, Pan C Y. Research on the stability of luminescence of $CsPbBr_3$ and Mn:$CsPbBr_3$ PQDs in polar solution[J]. RSC Advances, 2022, 12: 15420

[2] Zhao Y, Xie C, Zhang X, et al. Mn:$CsPbBr_3$ Nanoplatelets for Bright White-Emitting Displays[J]. ACS Applied Nano Materials, 2021, 4: 6223

[3] An M N, Park S, Brescia R, et al. Low-Temperature Molten Salts Synthesis: $CsPbBr_3$ Nanocrystals with High Photoluminescence Emission Buried in Mesoporous SiO_2[J]. ACS Energy Letters, 2021, 6(3): 900-907

[4] Rathod R, Das R, Das M R, et al. Plasma-Treated $CsPbBr_3$ Nanocrystal Films for Anticounterfeiting Applications[J]. ACS Applied Nano Materials, 2022, 5(7): 9852-9860

[5] Cao Y, Shao Y, Zhang J, et al. The photothermal stability study of silica-coated $CsPbBr_3$ perovskite nanocrystals[J]. Journal of Solid State Chemistry, 2022, 311: 123086

[6] Su Y, Zeng Q, Chen X, et al. Highly efficient $CsPbBr_3$ perovskite nanocrystals induced by structure transformation between $CsPbBr_3$ and Cs_4PbBr_6 phases[J]. Journal of Materials Chemistry C, 2019, 7: 7548-7553

[7] 郑哲轩. $CsPbBr_3$量子点及QLEDs器件性能的改善[D]. 天津理工大学, 2020

[8] Li G, Rivarola F W, Davis N J, et al. Highly Efficient Perovskite Nanocrystal Light-Emitting Diodes Enabled by a Universal Crosslinking Method[J]. Advanced Materials, 2016, 28(18): 3528-3534