STRUCTURAL AND LUMINESCENCE PROPERTIES OF MAGNESIUM SILICO-PHOSPHATE DOPED WITH EUROPIUM AND DYSPROSIUM IONS

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This thesis is dedicated to my

beloved husband, parents and family.

Thank you for being with me all along.

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ABSTRACT

Phosphor materials based on magnesium silico-phosphate was prepared via solid-state reaction method. The series of samples were in the form of xMgO (70-x) $SiO_2$30P_2O_5: yEu_2O_3, zDy_2O_3 with $0 \leq x \leq 30$ mol %, $0 \leq y \leq 1$ mol % and $0 \leq z \leq 4$ mol %. The X-ray diffraction pattern confirms that the synthesized material consists of SiO_2, SiP_2O_7, $Mg_2P_4O_{12}$ and $MgSiO_3$. FTIR spectroscopy was carried out to investigate the structure feature and vibrational study of phosphor material. The introduction of MgO yields the oxygen bridge like SiO^-, PO^-, Si-O-Si, P-O-P and Si-O-P linkages and was revealed that the hydroscopic properties from P_2O_5 can be reduced. Other than that MgO also take part in the formation of P=O:Mg by the breakdown of the vibration of double bond, P=O. The morphology and grain size of phosphor material was studied using SEM. It proves that doping material addition changes the morphology of host system. EDAX study was employed to give a clear evidence of doping material that had been used in this study. The photoluminescence characteristics originating of europium and dysprosium trivalent were also investigated. The addition of Dy^{3+} as co-dopant in the 20MgO-50SiO_2-30P_2O_5: 1Eu_2O_3 shows the quenching effect in the emission spectra. The photoluminescence intensity of Eu^{3+} decrease gradually with the concentration of the co-dopant in the range from 1 mol% to 4 mol%. The significantly intense emission peak was obtained at 474 nm (blue), 563 nm (yellow), 585 nm (orange), and 610, 645, and 658 nm (red) for 20MgO-50SiO_2-30P_2O_5: 1Eu_2O_3, 1Dy_2O_3. The energy absorbed by Dy^{3+} is transferred to Eu^{3+} and energy levels at each transition were provided. The transition of Eu^{3+}, $^5D_0 \rightarrow {}^7F_2$ and Dy^{3+}, $^4F_{9/2} \rightarrow {}^6H_{13/2}$ are hypersensitive electronic dipole transition and greatly affected by the coordination environment which are located at low-symmetry local site. Experimental results revealed that the luminescence can be affected by crystal structure, doping material concentration and morphology.

ABSTRAK

Bahan fosfor berasaskan kepada siliko-fosfat telah disediakan melalui kaedah tindakbalas keadaan pepejal. Siri sampel dalam bentuk xMgO (70-x) $SiO_2 30P_2O_5$: yEu_2O_3, zDy_2O_3 dengan $0 \leq$ x mol % ≤ 30 mol $0 \leq$ y mol≤ 1 dan $0 \leq$ z mol%≤ 4 telah disediakan. Corak pembelauan sinar-X (XRD) menunjukkan bahawa sintesis terdiri daripada SiO_2, SiP_2O_7 $Mg_2P_4O_{12}$ dan $MgSiO_3$. Spektroskopi FTIR dilakukan untuk menyiasat ciri-ciri struktur dan mengkaji getaran bahan fosfor. Pengenalan MgO menyebabkan berlakunya jambatan oksigen seperti SiO^-, PO^-, Si-O-Si, P-O-P dan hubugan Si-O-P yang membongkarkan sifat hidroskopik dari P_2O_5 dapat dikurangkan. MgO juga mengambil bahagian dalam pembentukan P=O:Mg dengan memusnahkankan getaran ikatan ganda dua, P=O. Morfologi dan saiz butiran bahan fosfor ditunjukkan oleh SEM. Ia membuktikan bahawa penambahan bahan dop telah mengubah morfologi sistem perumah. Kajian berdasarkan EDAX telah digunakan untuk menerangkan dengan jelas mengenai bahan dop yang telah digunakan dalam kajian ini. Ciri-ciri pendarcahaya berasal dari trivalensi Europium dan Dysprosium juga dikaji. Penambahan ion Dy^{3+} sebagai co-dopan di dalam $20MgO\text{-}50SiO_2\text{-}30P_2O_5$: $1Eu_2O_3$ menunjukkan kesan pemadaman di dalam spektrum pancaran. Keamatan pendarcahaya Eu^{3+} dari penurunan secara beransur dengan pertambahan co-dopan dalam julat dari 1 mol% hingga 4 mol%. Keamatan puncak pancaran yang penting telah diperolehi di 474 nm (biru), 563 nm (kuning), 585 nm (oren), dan 610, 645, dan 658 nm (merah) untuk $20MgO\text{-}50SiO_2\text{-}30P_2O_5$: $1Eu_2O_3$, $1Dy_2O_3$. Tenaga yang diserap oleh Dy^{3+} telah dipindahkan kepada Eu^{3+} dan aras tenaga pada setiap peralihan disediakan. Peralihan Eu^{3+}, $^5D_0 \rightarrow {}^7F_2$ dan Dy^{3+}, $^4F_{9/2} \rightarrow {}^6H_{13/2}$ peralihan dwikutub sensitif elektronik sangat dipengaruhi oleh keadaan persekitaran di bahagian tempatan simetri-rendah. Keputusan kajian menunjukkan bahawa pendarcahaya boleh dipengaruhi oleh struktur kristal, konsentrasi bahan dop dan morfologi.