PSW13A : 첨단세라믹 인력양성

PSW13A-1 | Preparation of gallium oxide with a morphology suitable for photocatalyst using a thermal evaporator

LEE Soohyun[1], HUH Yoonseo[1], *RYU Sangwoo[1]
[1]Kyonggi University

As global energy consumption rises, tackling excessive CO_2 emissions is vital to combat environmental problems like global warming. Photocatalysts are a promising solution gaining traction, offering a potential remedy for energy shortages. Semiconductor materials with suitable properties, like Gallium Oxide, show promise due to their bandgap and oxidation-reduction capabilities. However, Gallium Oxide's limited operation in the deep ultraviolet region and low light absorption efficiency hinder its use as a photocatalyst. This study aims to enhance CO_2 reduction efficiency by creating sphere-shaped gallium oxide using a thermal evaporator. After annealing, analysis with XRD and SEM confirms the samples' spherical structure retention. Utilizing this structure holds potential for improving CO_2 decomposition efficiency by expanding light absorption, suppressing carrier recombination, and improving charge transfer. These findings offer hope for addressing CO_2 emissions and their impact on the environment and energy resources.

PSW13A-2 | 우수한 열 안정성 및 향상된 X-ray imaging 특성을 보이는 0차원 비납계 신틸레이터 개발

서정민[1], 한주형[1], *임원빈[1]
[1]한양대학교

Scintillators are widely used for radiation detection in various fields, such as medical imaging, nondestructive testing, and crystallography. X-ray-generating systems typically emit large amounts of heat and require a high thermal stability of scintillators, particularly for nondestructive testing or radiation detection performed under harsh conditions. Therefore, highly stable scintillators must be developed for application in extreme environments. Herein, we developed new zero-dimensional lead-free monoclinic phases of Cs_3TbCl_6 and Rb_3TbCl_6 metal halides that are thermally and chemically stable. Cs_3TbCl_6 and Rb_3TbCl_6 polycrystals exhibit high light yields of 56,800 and 88,800 photons/MeV, respectively. Cs_3TbCl_6 and Rb_3TbCl_6 polycrystals also show low detection limits of 149.65 and 115.38 $nGyairs^{-1}$ due to their structural–optical properties, respectively. Furthermore, the fabricated thick films of Cs_3TbCl_6 and Rb_3TbCl_6 are applied to our homemade X-ray imaging system, and preferable spatial resolutions are obtained as compared with a commercial $Gd_2O_2S:Tb^{3+}$ film.

PSW13A-3 | 세 가지 다른 결정상을 가진 고적색 방출 망간 도핑 육각 페로브스카이트 소재에서 자가 트랩 엑시톤 역학에 대한 탐구

김유리[1], 한주형[1], *임원빈[1]
[1]한양대학교

Lead halide perovskites have gained tremendous attention since the past decade due to its excellent performance in optoelectronic devices. Numerous efforts in this direction have produced lots of lead-free metal halides. Herein, the synthesis of highly luminescent Cesium cadmium chloride through equivalent manganese doping at cadmium sites. Also, we synthesized $CsCd_{1-x}Mn_xCl_3$ into three forms: single crystal, polycrystalline powder, and nanocrystal. Rietveld refinement analysis of three different types of X-ray diffraction patterns of the as-synthesized three different forms of $CsCd_{1-x}Mn_xCl_3$ reveals their structural details. The high photoluminescent quantum yield for manganese emission was measured in the form of a single crystal (74%). The thermal stability of $CsCd_{1-x}Mn_xCl_3$ was studied and the material exhibited of orange-emitting, remain stable even at elevated temperatures—maintaining 80% of initial PL efficiency at 150°C. Lastly, we applied this material into white-light generating powder with mixing commercial phosphors.

PSW13A-4 | RF Sputtering 방식으로 증착된 $Zn_{0.85}Mg_{0.15}O$를 전자수송층으로 사용한 높은 휘도의 양자점 전계 발광 다이오드에 관한 연구

김보미[1], *김지완[2]
[1]경기대학교

Colloidal quantum dots (QDs) have unique electrical and optical properties through quantum effect such as easy emission tunability and narrow full width at half maximum. ZnO nanoparticles (NPs) are widely used as an electron transport layer (ETL) of QLEDs, but they can cause charge imbalance in the emission layer (EML) due to their high electron mobility. In addition, intrinsic oxygen vacancies and surface defects in ZnO NPs act as non-radiative recombination centers, thereby degrade the performance. Generally, Mg is doped to increase the band gap or a charge blocking layer is deposited to control the movement of electrons, in order to solve this problem. However, for QLEDs, there are few reports on ZnMgO ETL deposited by RF sputtering.

In this work, we fabricated QLEDs with a $Zn_{0.85}Mg_{0.15}O$ layer as an ETL by RF sputtering. The deposition condition of $Zn_{0.85}Mg_{0.15}O$ layer was optimized by controlling the partial pressure of O_2 and RF power for the best EL performance. As a result, the QLEDs with an inverted structure showed the maximum luminance and current efficiency of 62,404 cd/m^2 and 13.93 cd/A, respectively. Mg doping effectively reduced the defect sites induced by oxygen vacancy. Additionally, QLEDs with a $Zn_{0.85}Mg_{0.15}O$ layer deposited by RF sputtering can be dramatically improved by the balanced injection of electrons and holes. Also, the optical properties were compared after fabricating QLEDs using ZnO/sputtered-ZnMgO double layers as an ETL.

PSW13A-5 | Improved stability of quantum dot light emitting diode using VO_2 as a hole injection layer

조한빈[1], *임원빈[2]
[1]한양대학교

Quantum dot light-emitting diodes (QLEDs) are promising devices for display applications. Polyethylenedioxythiophene:polystyrene sulfonate (PEDOT:PSS) is a common hole injection layer (HIL) material in optoelectronic devices because of its high conductivity and high work function. Nevertheless, PEDOT:PSS-based QLED has a high energy barrier for hole injection, which results in low device efficiency. Therefore, a new strategy is needed to improve the device efficiency. Herein, we have demonstrated a bilayer-HIL using VO_2 and PEDOT:PSS-based QLED that exhibits an 18% external quantum efficiency (EQE), 78 cd/A current efficiency, and 25,771 cd/m^2 maximum luminance. In contrast, PEDOT:PSS-based QLED exhibits the EQE of 13%, current efficiency (CE) of 54 cd/A, and maximum luminance of 14,817 cd/m^2. An increase in EQE was attributed to a reduction in the energy barrier between indium tin oxide (ITO) and PEDOT:PSS, caused by the insertion of VO_2 HIL. Therefore, our results could demonstrate that using a bilayer-HIL is effective in increasing the EQE in QLEDs.

PSW13A-6 | 공정조건 변화에 따른 사파이어(Al2O3) 단결정 Ingot 소재내 Haze 분석

홍석진[1], *정운진[1]
[1]공주대학교

사파이어 단결정은 최근 반도체, LED 산업의 발전과 더불어 기판소재로 활용되며 급속도로 성장하고 있으며, 광학계 렌즈나 방위산업용 Window로 사파이어 소재가 적용됨에 따라 고품질 대면적 사파이어 소재생산이 요구되고 있다. 또한 최근 중국과의 경쟁으로 국내외 시장에서의 원가경쟁력 확보가 필요하다. 사파이어 생산은 고온(2000 ℃)에서 10~25일에 걸쳐 단결정을 성장시키는 방식으로 소재가 생산되어 타 세라믹 소재 대비 생산성이 떨어진다. 이를 극복하기 위해 장비 및 공정개선을 통해 일부 생산성 향상을 확보하였으나, 사파이어 Ingot내 다양한 결함에 의해 발생되는 Haze에 의해 생산 수율이 제한되는 문제가 있어, 그 원인 분석과 해결방안이 시급하다. 본 연구에서는 사파이어 단결정에서 발생하는 Haze와 관련된 문헌을 조사하고 Haze meter, SEM, 투과도 등을 분석하여 Haze 발생 원인을 분석하였다. 문헌 조사를 통해 Oxygen vacancy, Micro bubble 등의 영향으로 추정하였다. 문헌 조사를 토대로 확인된 사파이어 단결정내 Haze를 최소화 하기 위해 산화제 SnO_2, Sb_2O_3, SiO_2 추가 도핑, 성장 속도 변화 등 다양한 공정 개선 방향을 제시하고 실시하였으며, 공정 조건 변화에 따른 사파이어 단결정내 Haze 변화를 Haze meter 및 가시광 투과도 분석을 통해 관찰하였다.

PSW13A-7 | 국부 표면 플라즈몬 효과에 의한 상향 변환 나노입자의 효율 향상

장성우[1], SAMANTA Tuhin[1], *임원빈[1]
[1]한양대학교

Upconversion material that convert infrared light into visible and ultraviolet photon are capable of a broad range application such as deep tissue bio-imaging, security labelling and anti-counterfeit, etc. Lanthanide-doped sodium yttrium fluoride ($NaYF_4$) upconversion nanoparticles (UCNP) are one of the most efficient UCNPs. However, the practical application of upconverting materials is limited owing to their extremely weak and narrow band absorption. Moreover, it is still a great challenge to short-wave infrared photon (such as 1550 nm) to visible since photon should be 3-pumped for visible region emission which hamper itself to a wide variety of applications. To solve this problem, we applied the localized surface plasmon resonance (LSPR) effect of indium tin oxide (ITO) NPs to enhance the 1550 nm absorbance of $NaYF_4:Er^{3+}$ NPs. We have synthesized core-shell $NaYF_4:Er^{3+}@NaYF_4$ NPs with particles size distribution of 15 nm via co-precipitation synthesis method. Synthesized 7 nm particle sized ITO NPs (Sn 5 mol% doped) exhibit intense LSPR effect in the range of 1400 to 1800 nm that perfectly overlap with 1550 nm excitation of Er^{3+} ions. We characterized upconversion efficiency of $NaYF_4:Er^{3+}@NaYF_4$ UCNPs with ITO NPs mixture solution with 1550 nm laser (10 $mWcm^{-1}$). Upconversion luminescence (UCL) shows 1.93 times enhancement when cooperated with ITO NPs. Finally, we proposed UCL enhancement mechanism through pump power dependency of the green and red UC intensity.