

## Supplementary Information

Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.  
This journal is © The Royal Society of Chemistry 2018

### **Evolution of Highly Efficient Rare-earth Free $\text{Cs}_{(1-x)}\text{Rb}_x\text{VO}_3$ Phosphor as a Single Emitting Component for NUV-based White LEDs**

*E. Pavitra<sup>a</sup>, G. Seeta Rama Raju<sup>b</sup>, L. Krishna Bharat<sup>c</sup>, Jin Young Park<sup>d</sup>, Cheol Hwan Kwan<sup>a</sup>,*

*Jong Won Chung<sup>d</sup>, Young-Kyu Han<sup>\*b</sup>, Yun Suk Huh<sup>\*a</sup>*

*<sup>a</sup>Department of Biological Engineering, Biohybrid Systems Research Center (BSRC), Inha University, Incheon, 22212, Republic of Korea*

*<sup>b</sup>Department of Energy and Materials Engineering, Dongguk University-Seoul, Seoul 04620, Republic of Korea*

*<sup>c</sup>Center of Biomedical Engineering, Institute of Molecular Medicine, Sechenov University, Moscow 119991, Russia*

*<sup>d</sup>Department of LED Convergence Engineering, Pukyong National University, Yongdang Campus, Busan, 48547, Republic of Korea*

*Address Correspondence to*

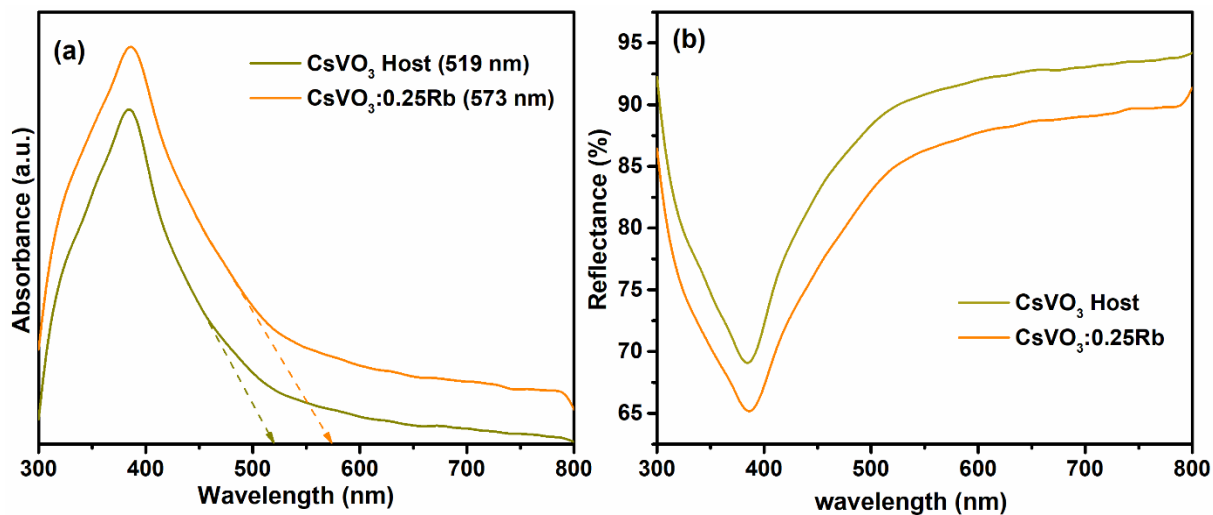
*\*E-mail: [ykenergy@dongguk.edu](mailto:ykenergy@dongguk.edu) (Prof. Y.-K. Han) [yunsuk.huh@inha.ac.kr](mailto:yunsuk.huh@inha.ac.kr) (Prof. Y. S. Huh)*

## Supplementary Information

### Characterizations

The morphologies of the prepared samples were recorded using high-resolution field-emission scanning electron microscope (HR FE-SEM, Hitachi-SU8010, Japan). Elemental mappings were obtained with the energy dispersive X-ray spectroscopy (EDX), which were attached with the SEM instrument. X-ray diffraction (XRD) patterns were measured on X'Pert Pro MRD (PANalytical, Holland) system. The room-temperature PL spectra were recorded on a Photon Technology International (PTI, USA) fluorimeter with a Xe-arc lamp of 60 W power and the lifetime was measured with a phosphorimeter attachment to the main system with 25 watt power Xe-flash lamp. The temperature-dependent PL properties were evaluated by using Scinco FS-2 fluorescence spectrophotometer. The quantum yield (or internal quantum efficiency and external quantum efficiency) measurements were carried out by an integrating sphere equipped fluorescence spectrophotometer (Hamamatsu Photonics C9920-02). The EL spectra were measured using OL 770 multi-channel spectroradiometer (Gooch & Housego, 770VIS, U.S.A).

## Supplementary Information



**Fig. S1** (a) Absorption and (b) diffuse reflectance spectra of CsVO<sub>3</sub> host and CsVO<sub>3</sub>:0.25Rb phosphors.

## Supplementary Information

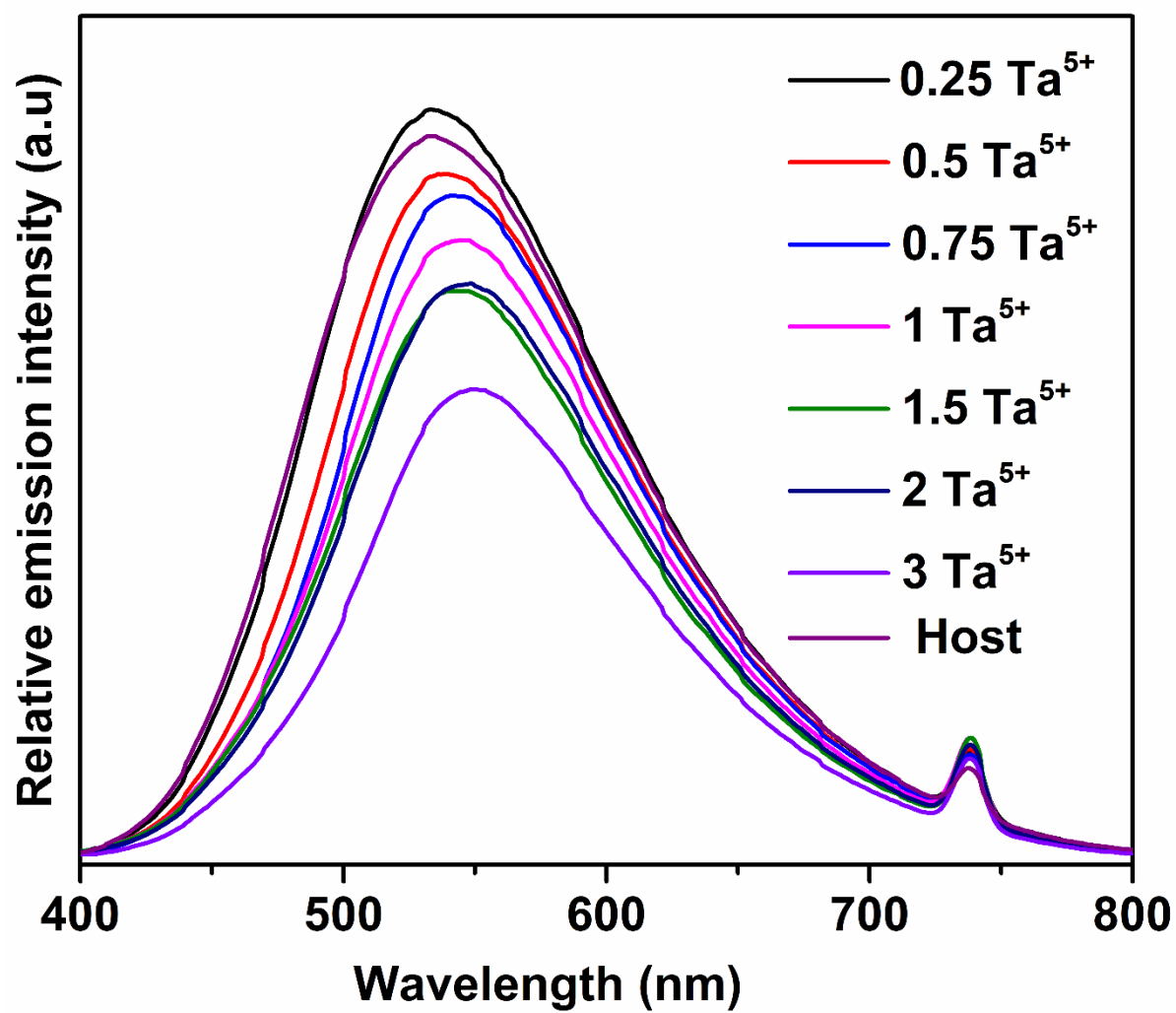
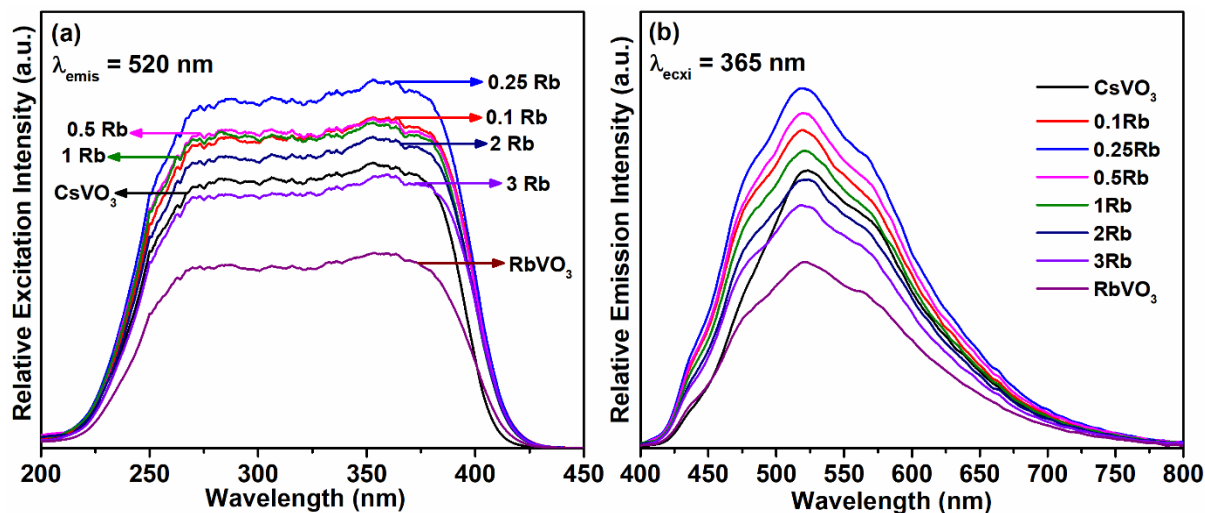
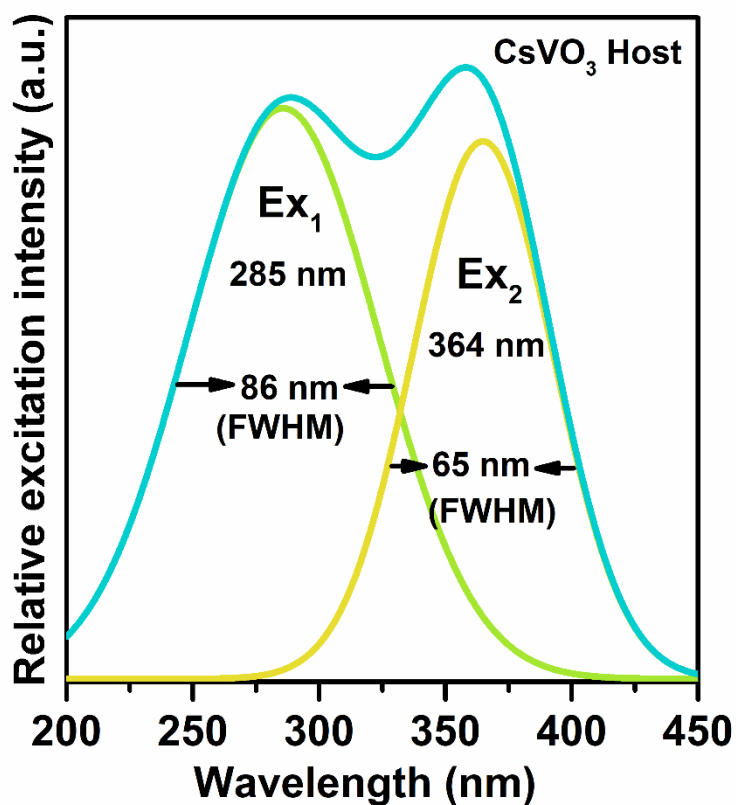


Fig. S2 PL emission spectra of CsVO<sub>3</sub> yellow phosphor as a function of Ta<sup>5+</sup> ions concentration from 0.25 to 3 mol%.

## Supplementary Information



**Fig. S3** PLE and PL emission spectra of different concentrations of  $\text{Rb}^{1+}$  ions activated  $\text{CsVO}_3$  by monitoring the corresponding emission wavelength at 520 nm and excitation wavelength at 365 nm, respectively.



**Fig. S4** Gaussian fitting curves for  $\text{CsVO}_3$  host by monitoring the emission wavelength at 520 nm.

## Supplementary Information

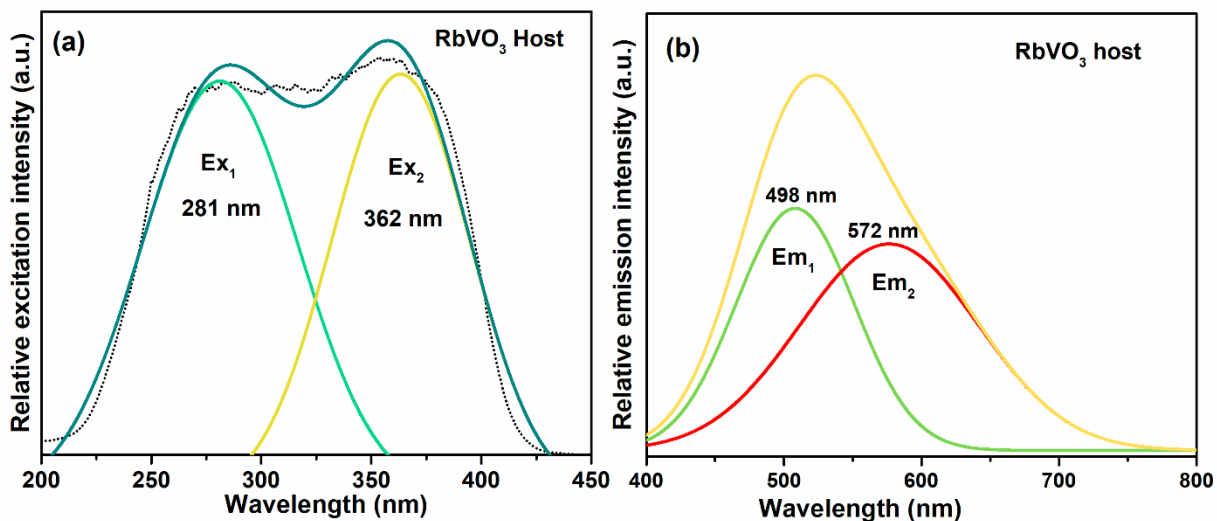


Fig. S5 Gaussian fitting curves of RbVO<sub>3</sub> excitation (a) and emission (b) spectra by monitoring the emission wavelength at 520 nm and excitation wavelength at 365 nm, respectively.

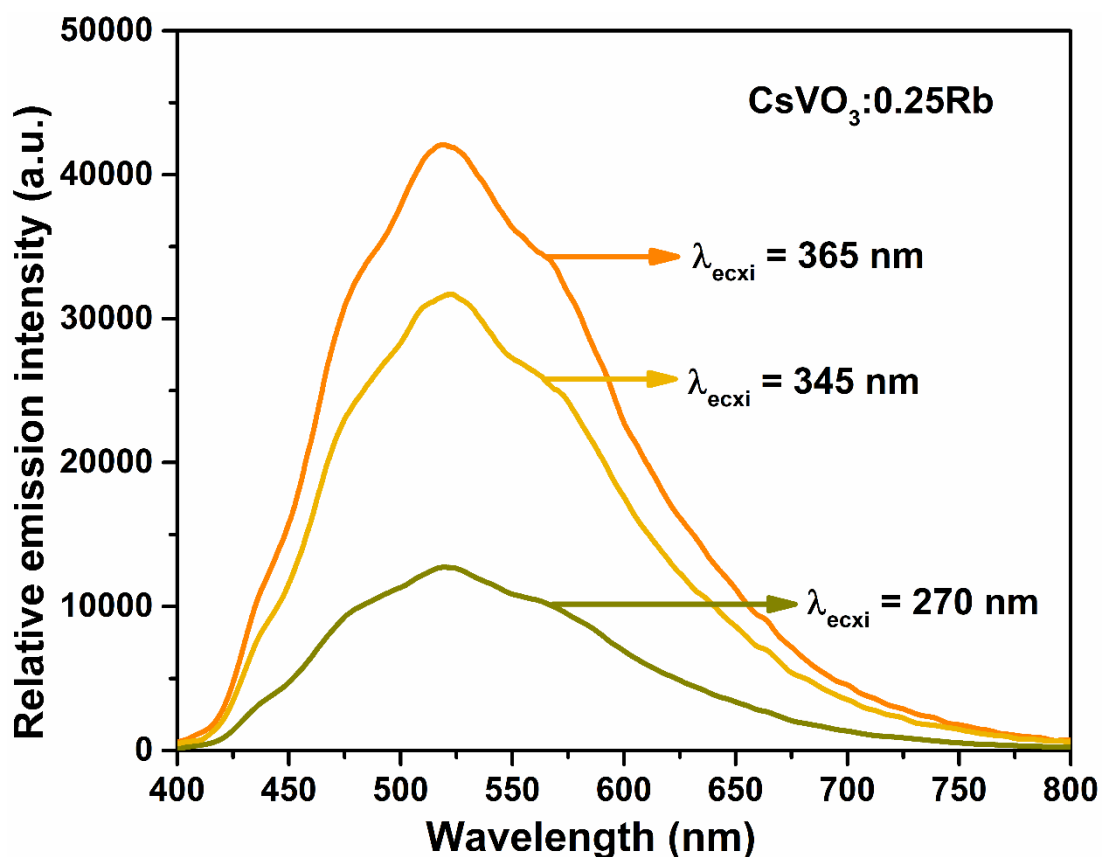
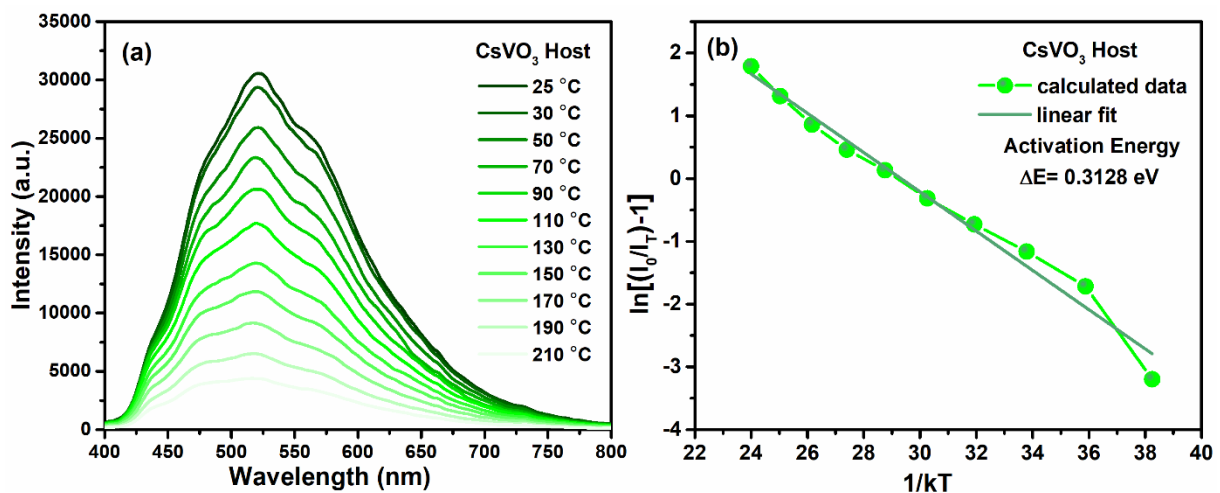
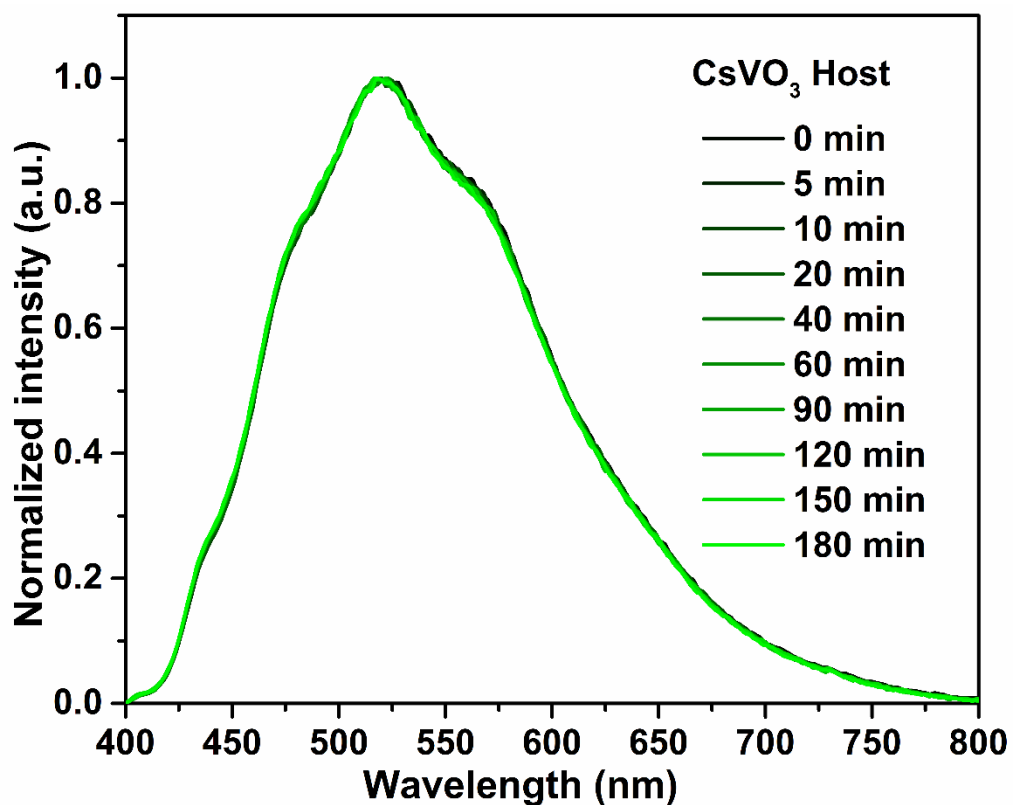


Fig. S6 PL emission spectra of CsVO<sub>3</sub>:0.25Rb phosphors under different excitation wavelengths.

## Supplementary Information



**Fig. S7** (a) Temperature-dependent PL emission spectra of the CsVO<sub>3</sub> host as a function of temperatures from 25 to 210 °C, respectively, (b) The corresponding activation energy plot fitted with the Arrhenius equation.



**Fig. S8** Comparison of normalized PL spectra of CsVO<sub>3</sub> host under different illumination timings for 3 h.