

Supporting Information for:

**Photoluminescence Properties of Double Perovskite Tantalates Activated  
with  $\text{Mn}^{4+}$ ,  $AE_2\text{LaTaO}_6\text{:Mn}^{4+}$  ( $AE = \text{Ca, Sr, and Ba}$ )**

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**Table S1.** Lattice parameters for three super cells.<sup>a)</sup>

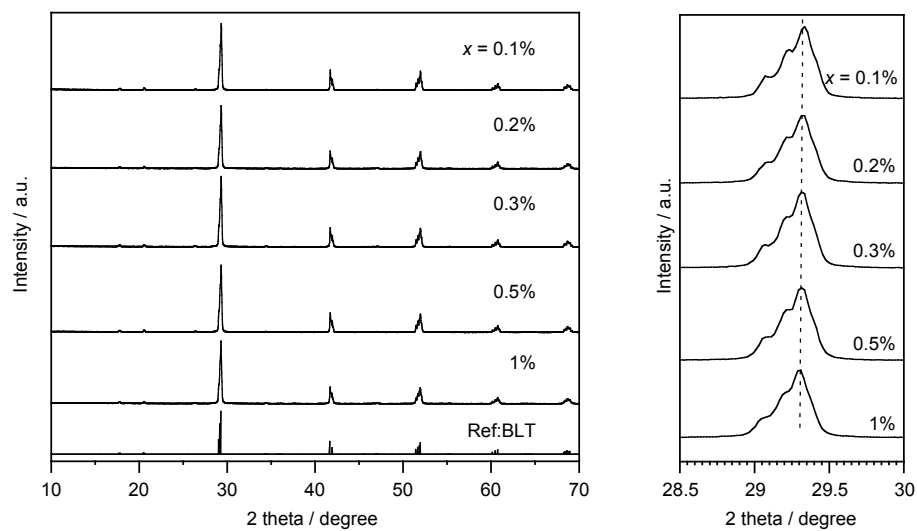
|                                                             | $a$    | $b$    | $c$    | $\alpha$ | $\beta$ | $\gamma$ |
|-------------------------------------------------------------|--------|--------|--------|----------|---------|----------|
| $\text{Ca}_{32}\text{La}_{16}\text{Ta}_{15}\text{MnO}_{96}$ | 11.344 | 11.780 | 16.332 | 90       | 90.09   | 90       |
| $\text{Sr}_{16}\text{La}_8\text{Ta}_7\text{MnO}_{48}$       | 11.810 | 11.810 | 11.810 | 60       | 60      | 60       |
| $\text{Ba}_{32}\text{La}_{16}\text{Ta}_{15}\text{MnO}_{96}$ | 12.291 | 12.189 | 17.218 | 90       | 90.34   | 90       |

a) Units are angstrom and degree.

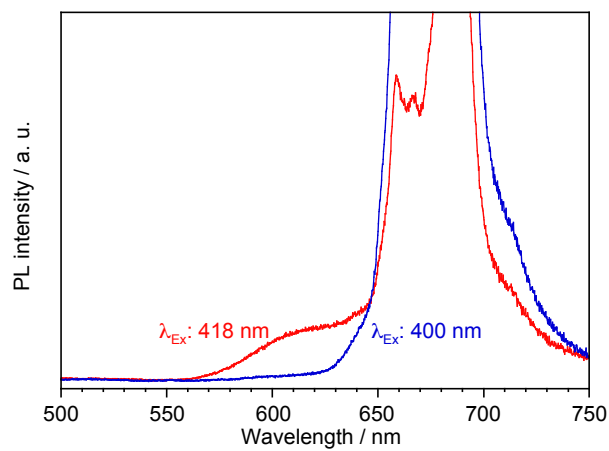
**Table S2.** The bond lengths of Mn-O in  $\text{Mn}^{4+}$ -doped tantalates after structure optimization<sup>a)</sup>

|         | $\text{Ca}_{32}\text{La}_{16}\text{Ta}_{15}\text{MnO}_{96}$ | $\text{Sr}_{16}\text{La}_8\text{Ta}_7\text{MnO}_{48}$ | $\text{Ba}_{32}\text{La}_{16}\text{Ta}_{15}\text{MnO}_{96}$ |
|---------|-------------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------|
|         | 1.927                                                       | 1.885                                                 | 1.963                                                       |
|         | 1.927                                                       | 1.885                                                 | 1.963                                                       |
|         | 1.932                                                       | 1.885                                                 | 1.982                                                       |
|         | 1.932                                                       | 1.885                                                 | 1.982                                                       |
|         | 1.960                                                       | 1.885                                                 | 1.960                                                       |
|         | 1.960                                                       | 1.885                                                 | 1.960                                                       |
| Average | 1.940                                                       | 1.885                                                 | 1.968                                                       |

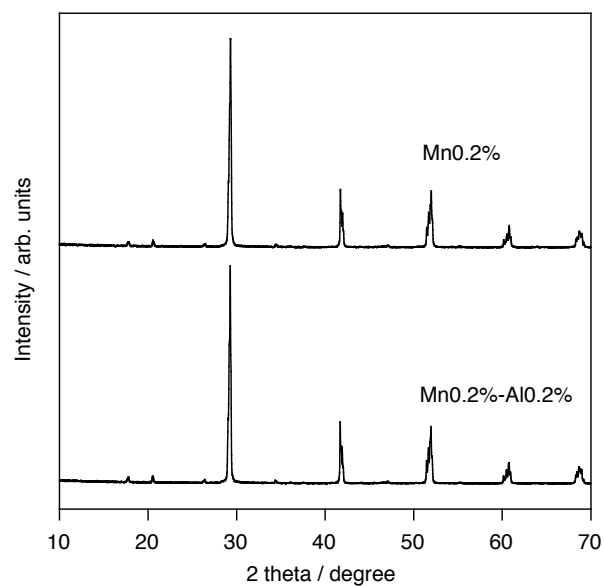
a) In a unit of angstrom.



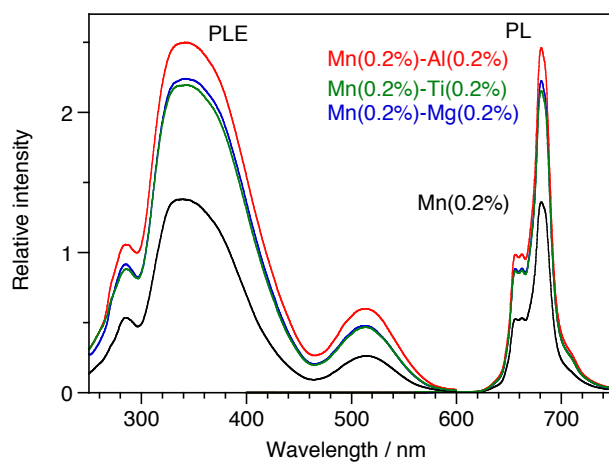
**Figure S1.** XRD patterns of BLT:Mn ( $x = 0.1\text{--}1\%$ ) with a reference of  $\text{Ba}_2\text{LaTaO}_6$  (ICSD#: 290859).



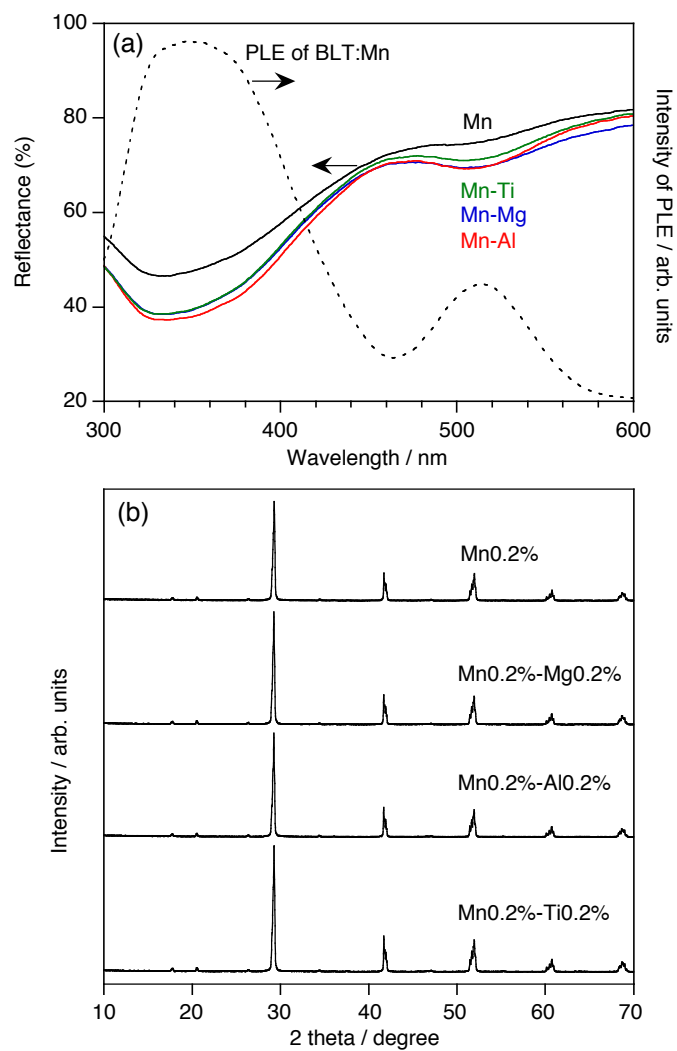
**Figure S2.** PL spectra of reduced BLT:Mn1% taken under excitation at 400 and 418 nm.



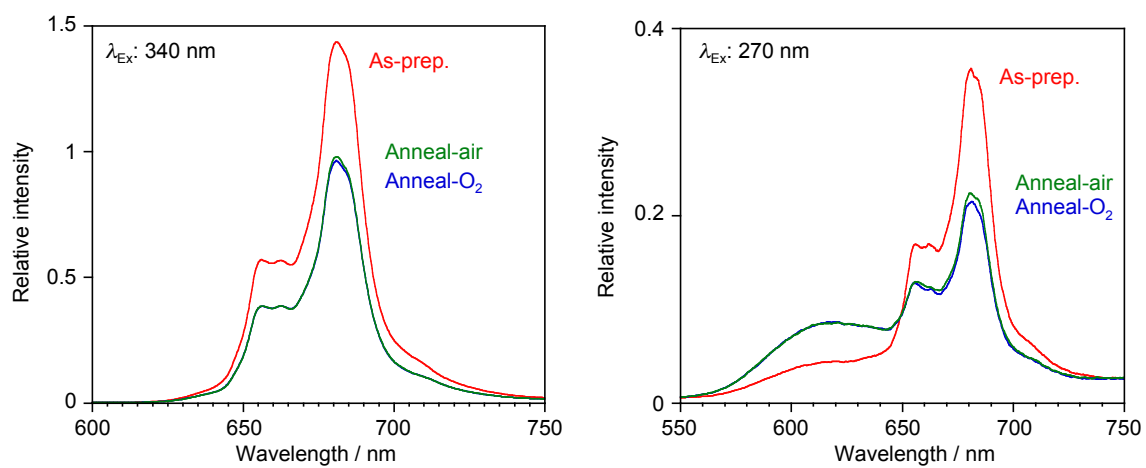
**Figure S3.** XRD patterns of BLT:Mn(0.2%) and BLT:Mn(0.2%)-Al(0.2%).



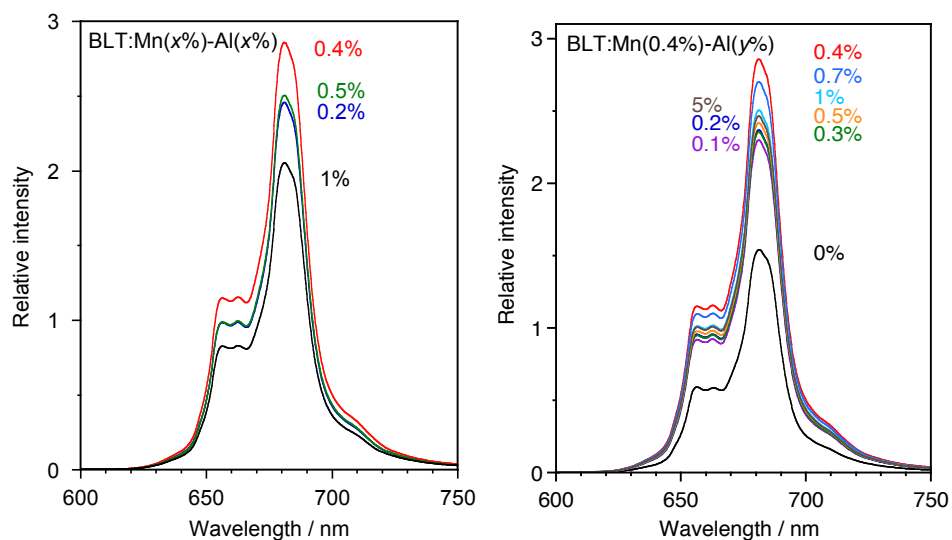
**Figure S4.** PL and PLE spectra of BLT:Mn(0.2%) and BLT:Mn(0.2%)-M(0.2%), M = Mg, Al, and Ti. Excitation and monitoring wavelengths are 350 nm and 681 nm, respectively.



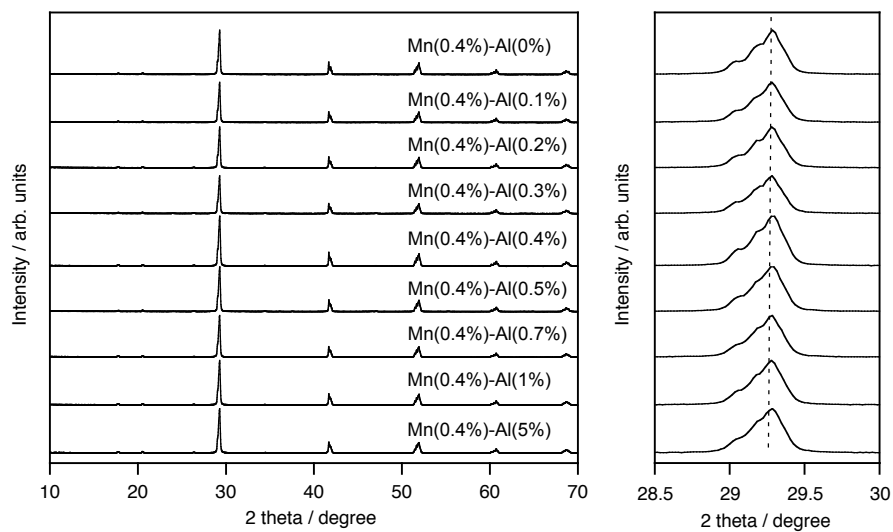
**Figure S5.** (a) Reflectance spectra of BLT:Mn(0.2%) and BLT:Mn(0.2%)-M(0.2%) with a PLE spectrum of BLT:Mn and (b) XRD patterns of BLT:Mn(0.2%) and BLT:Mn(0.2%)-M(0.2%).



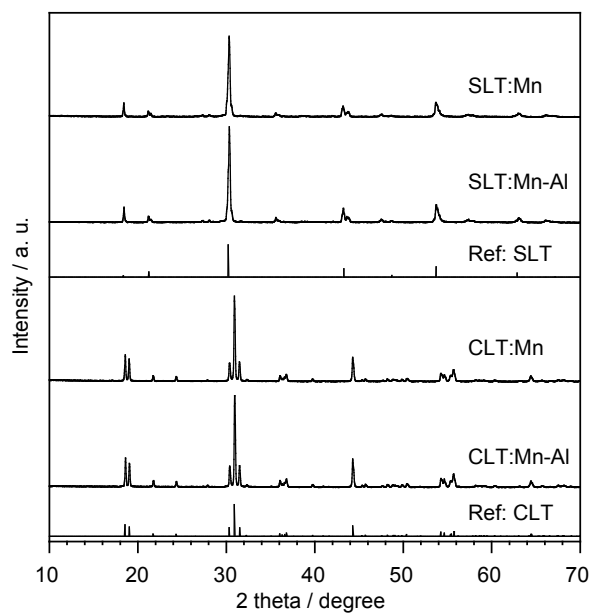
**Figure S6.** PL spectra of BLT:Mn(0.2%); as-prepared and annealed in air and O<sub>2</sub> at 1473 K for 5 h.



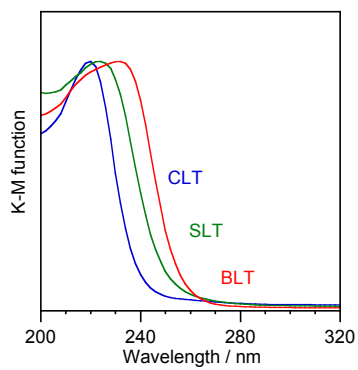
**Figure S7.** PL spectra of BLT:Mn( $x\%$ )-Al( $x\%$ ) and BLT:Mn(0.4%)-Al( $y\%$ ) excited at 340 nm.



**Figure S8.** XRD patterns of BLT:Mn(0.4%)-Al( $y\%$ ).



**Figure S9.** XRD patterns of  $AE_2\text{LaTaO}_6$  ( $AE = \text{Ca}$  and  $\text{Sr}$ ) doped with  $\text{Mn}(0.5\%)$  and  $\text{Mn}(0.4\%)\text{-Al}(0.4\%)$ . Reference patterns of CLT and SLT are also shown.



**Figure S10.** UV-vis spectra of non-doped  $AE_2\text{LaTO}_6$ .