TEMPERATURE DEPENDENT PHOTOLUMINESCENCE AS A METHOD OF DETECTING REVERSIBLE PHASE TRANSITIONS IN WATER RESISTANCE 2D PEROVSKITE SEMICONDUCTORS

Mahboubeh Jamshidi, James Gardner

Department of Chemistry, Division of Applied Physical Chemistry, KTH Royal Institute of Technology, SE-100 44 Stockholm, Sweden

Two-dimensional (2D) lead halide perovskite semiconductors are a family of materials at the heart of solar cell, light-emitting diode, and photodetector technologies. They have been developed as materials with improved moisture, heat, and light stability due to their long chain organic molecules.[1] 2D perovskite compounds undergo phase transition as a matter of effecting the temperature on the crystal lattice rearrangement which has a significant impact on the band alignment and the device efficiency.[2] Phase transition has been confirmed by different methods such as differential scanning calorimetry (DSC), differential thermal analysis (DTA) techniques, and single crystal X-ray diffraction.[3, 4]

Herein, we witness the multiple phase transition of the last members of a series of inorganic−organic hybrid materials, $[(C_nH_{2n+1}NH_3)_2PbI_4]$, with n = 14, 16, and 18, once again with temperature-dependent steady-state photoluminescence (PL) and temperature-dependent time-resolved photoluminescence (TRPL) spectroscopy in the temperature range of 77 to 370 K. A red shift in the corresponding photoluminescence (PL) peak is observed by raising the temperature from 77 K to room temperature together with the arrival of the new emission band, followed by vanishing of the first emission band when heating up to 360 K (Figure 1). Decay times show singlet and triplet excitons at room temperature. However, the longer photoluminescence decay (triplet) at low temperature (77 K) as compared to room temperature is disappeared in $(C_{18}H_{37}NH_3)_2PbI_4$.

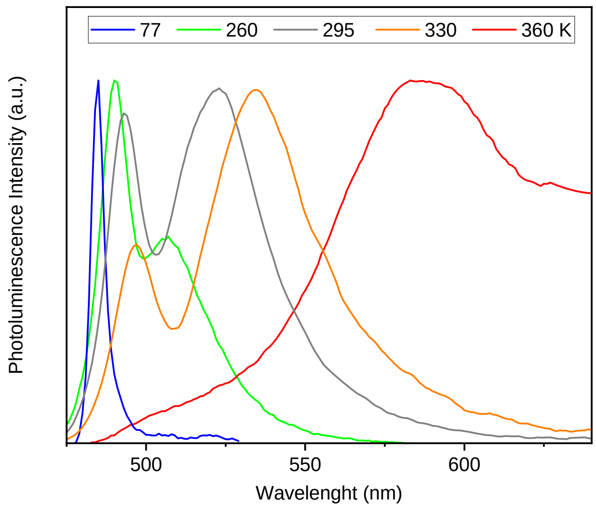

Figure 1. Normalized photoluminescence spectra of $(C_{18}H_{37}NH_3)_2PbI_4$ at different temperatures showing thermochromism of $(C_{18}H_{37}NH_3)_2PbI_4$.

[1] E. Elahi, et. al. Dalton Transactions, 51 (2022) 797

[2] M.S. Kirschner, et. al. Nature Communications, 10 (2019) 504

[3] B.P. Kore, J.M. Gardner, Materials Advances, 1 (2020) 2395

[4] D.G. Billing, A. Lemmerer, New Journal of Chemistry, 32 (2008) 1736