Synthesis and photoluminescence stability of novel RE (Pr,Ce) / W double perovskites based on oxygen and barium

Damian Włodarczyk[1], M. Amilusik[2], M. Chrunik[3], R. Islam[1], A. Suchocki[1]

[1]IP PAS, Ave. Lotnikow 32/46, 02-668, Warsaw, Poland *[2]IHPP PAS, Sokolowska 29, 01-142, Warsaw, Poland*

[3]Military University of Technology, Gen. S. Kaliskiego 2, 00-908, Warsaw, Poland

Solid State Synthesis & XRD

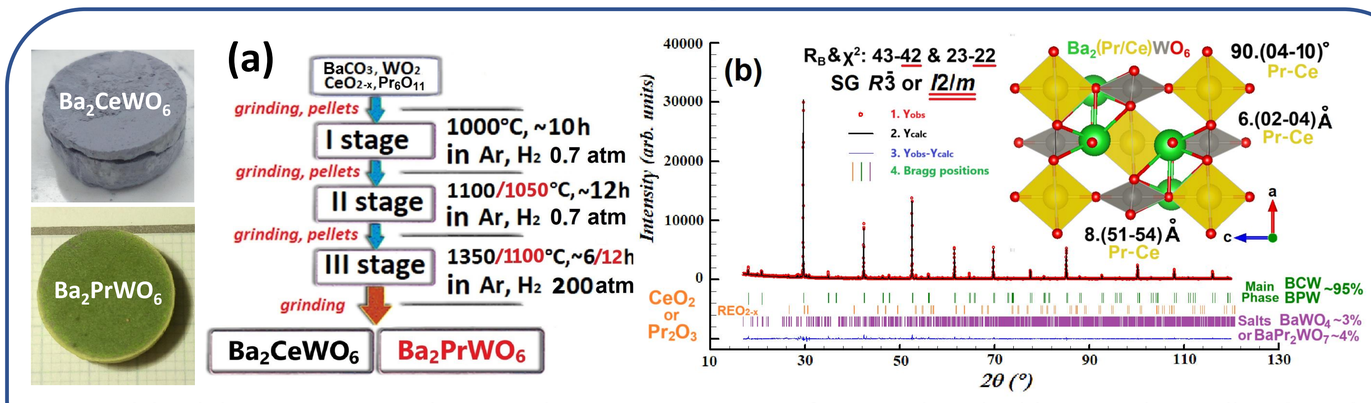

Fig. 1 (a) Solid state reaction scheme and respective pictures of acquired Ba double perovskite pellets **(BCW)** Ba_2CeWO_6 & Ba_2PrWO_6 **(BPW)**, and (b) their typical unit cell with XRD Rietveld-refined diffraction pattern.

Ideology & Motivation

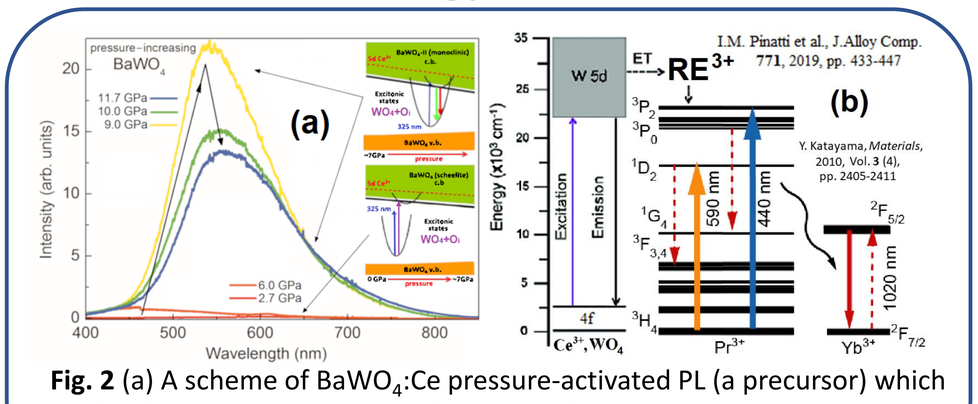

Fig. 2 (a) A scheme of $BaWO_4$:Ce pressure-activated PL (a precursor) which inspired the development of our materials, and (b) energy transfer mechanism reported for it which should also be possible in our case.

Research & Development of Energy Transfer

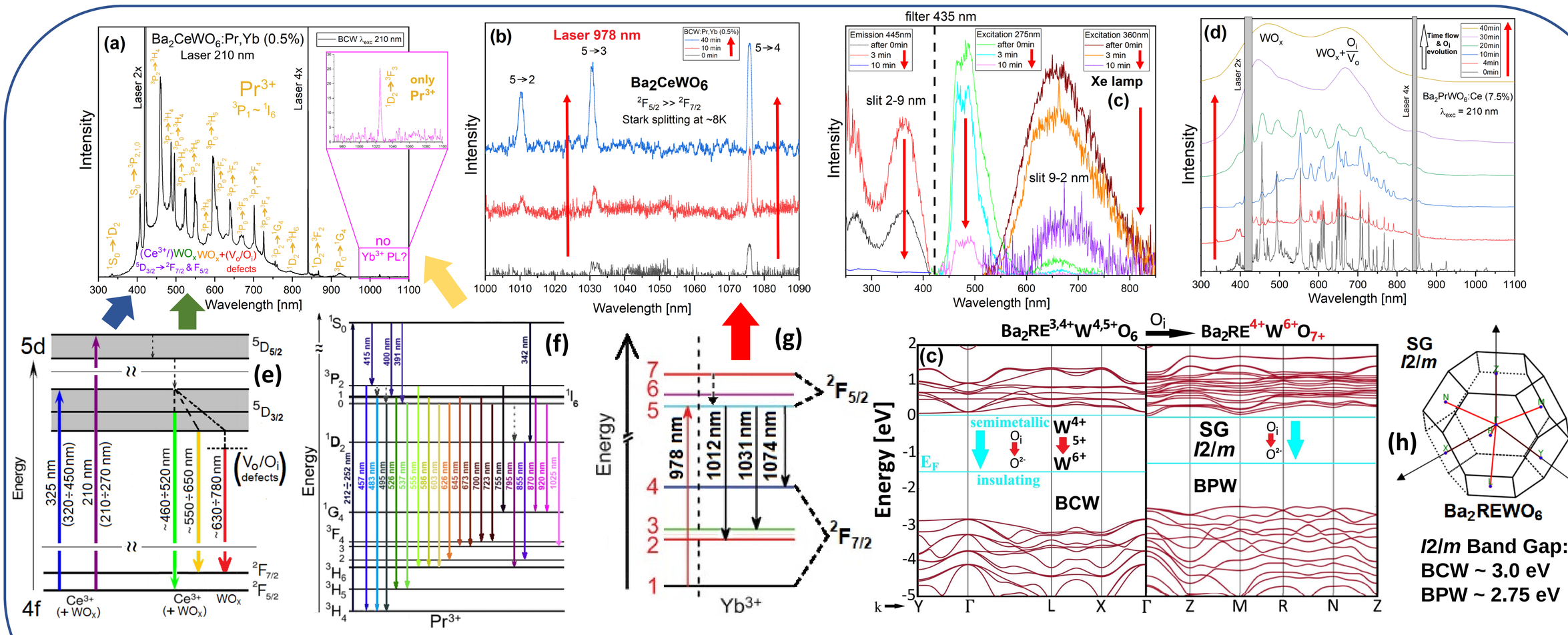

Fig. 3 Luminescence spectra (a, b, c, d) depicting the progress/effects of the expected energy transfer (it failed in **NUV => VIS => NIR** region). Below these figures, schemes (e, f, g) of with registered, radiative transitions are shown for estimated down conversion through **Ce/Pr^{3+} => WO_x => Yb^{3+}**. Double perovskites turn out to be radiatively unstable - a diagram summarizing changes during exposition in theoretically predicted band-gaps is show in fig (h). Mechanisms governing such behavior are presented in Fig. 4 below.

Charge Transfer & Time-Resolved Ion Evolution

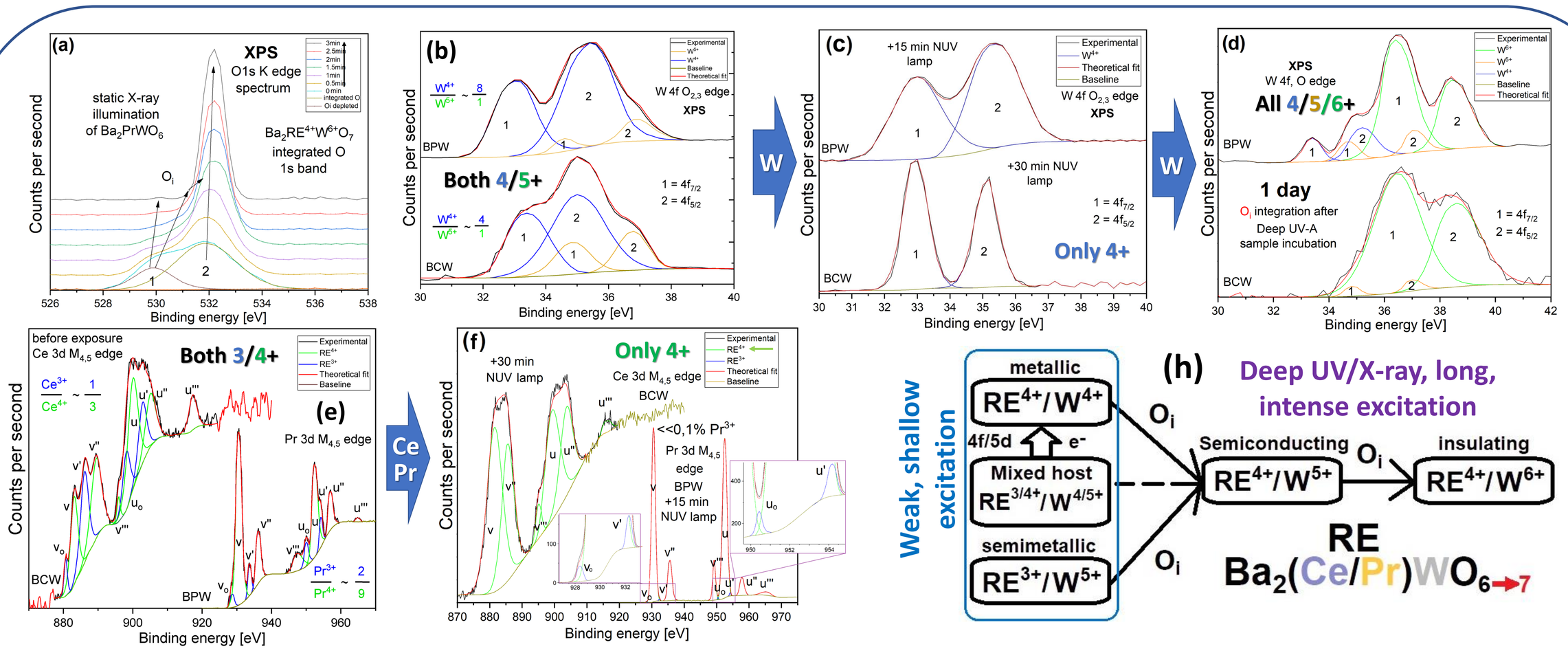

Fig. 4 X-ray spectra of changing core cations present in illuminated double perovskites (Ba_2CeWO_6 & Ba_2PrWO_6). Showcased matrices undergo irreversible charge transfer of: (a) trapped, interstitial oxygen (O_i) integration towards O^{2-}; (b, c, d) $W^{4/5/6+}$ while being exposed to Xe lamp and NUV laser respectively; and (e, f) Ce & Pr ions evolution mostly from 3^+ to 4^+ state. Graph (h) summarizes all aforementioned processes into one, concise photosensitive chain of reactions.

Summary: ➢Unstable phosphors ➢Untimely quenched PL (in N_2 & air) ➢Irreversible charge transfer/O_i evolution ➢No RE^{3+} (Ce/Pr) => WO_x => Yb^{3+} ; NUV => VIS => NIR energy transfer ➢Good, one-way UV or deeper-radiation sensor

This work was supported by Polish NSC Preludium 17 grant no. *2019/33/N/ST5/02317* & exchange of knowledge would not be possible without Pol-Sin collaboration program Sheng 2 (*no. 2021/40/Q/ST5/00336*) & Grant *no. 52161135110* from NNSF China.