Supplementary Information

Unique phonon modes of a $CH_3NH_3PbBr_3$ hybrid perovskite film without the influence of defect structures: an attempt toward a novel THz-based application

Inhee Maeng[1+], Seungjun Lee[2+], Hiroshi Tanaka[3+], Jung-Ho Yun[4], Shenghao Wang[5], Masakazu Nakamura[3], Young-Kyun Kwon[2*], and Min-Cherl Jung[6*]

[1]YUHS-KRIBB, Medical Convergence Research Institute, College of Medicine,Yonsei University, Seoul, 03722, Republic of Korea

[2]Department of Physics, Kyung Hee University, Seoul, 02447, Republic of Korea

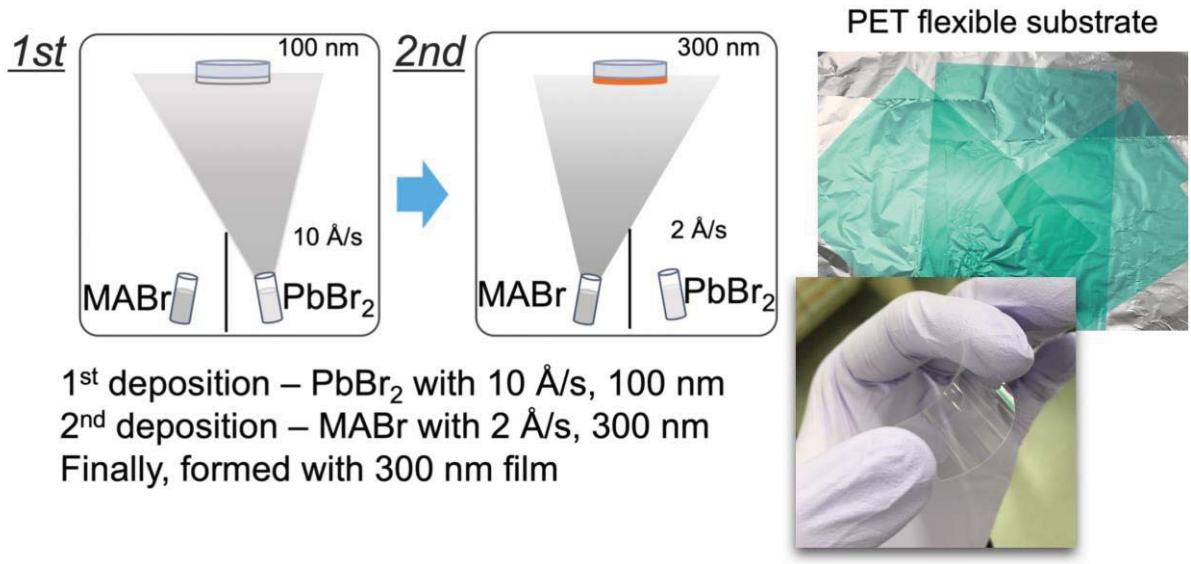
[3]Division of Materials Science, Nara Institute of Science and Technology, Nara, 630-0192, Japan

[4]School of Chemical Engineering and Australian Institute for Bioengineering and Nanotechnology (AIBN), University of Queensland, QLD 4027, Australia

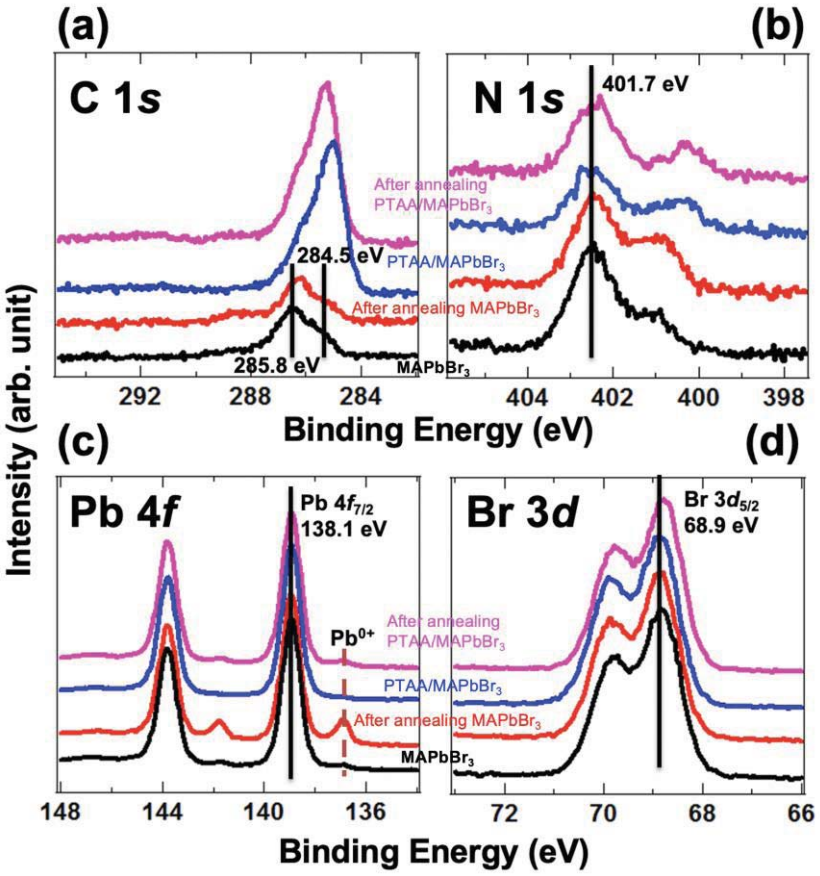
[5]Materials Genome Institute, Shanghai University, Shanghai, 200444, China

[6]Division of Materials Science, Faculty of Pure and Applied Sciences, University of Tsukuba, Ibaraki, 305-8577, Japan

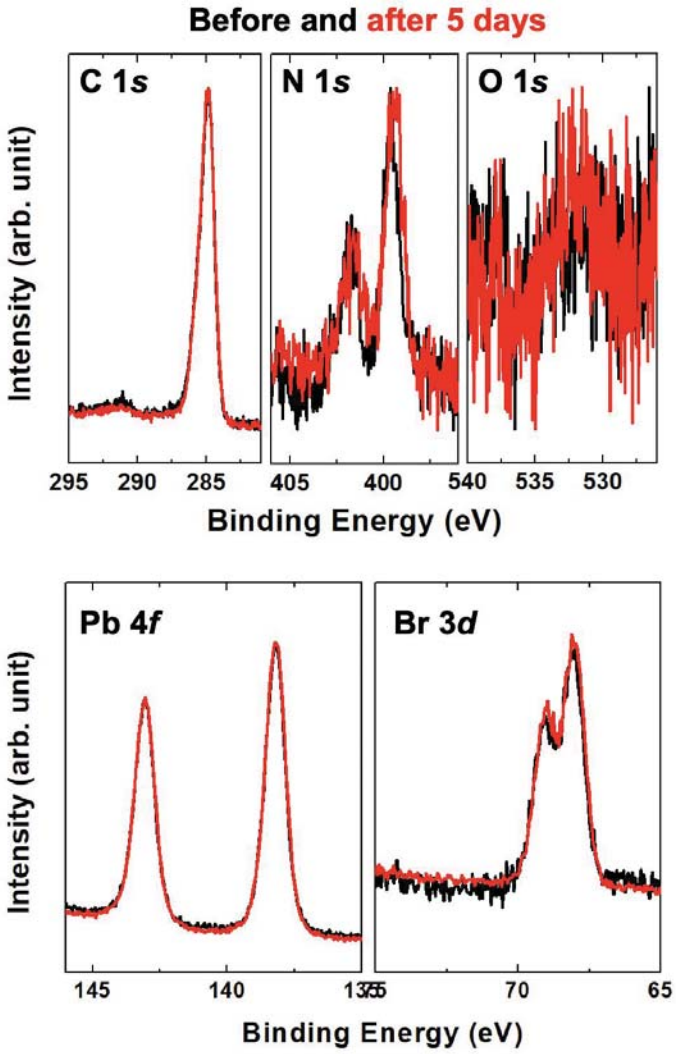
S.Figure 1. The schematic of sequential vacuum evaporation method and the PET flexible substrate.



S.Figure 2. Core-level spectra of (a) C 1*s*, (b) N 1*s*, (c) Pb 4*f*, and Br 4*d*. There is no defect-related chemical state except of CH_3NH_2 molecular defect. We could not observe any O 1*s* trace.



S.Figure 3. XPS measurement of PTAA/$MAPbBr_3$/PET before and after 5 days on the air. We could not find any significant contamination.



S.Figure 4. THz-TDS measurement for the PET and PES flexible substrates