Excellent microwave absorption of lead halide perovskites with high stability

Heng Guo,[a] Jian Yang,[a] Bingxue Pu,[a] Haiyuan Chen,[a] Yulan Li,[a] Zhiming Wang,[b] and Xiaobin Niu*[a,b]

[a.] State Key Laboratory of Electronic Thin Film and Integrated Devices, School of Materials and Energy, University of Electronic Science and Technology of China, Chengdu 610054, P. R. China

[b.] Institute of Fundamental and Frontier Sciences, University of Electronic Science and Technology of China, Chengdu 610054, P. R. China

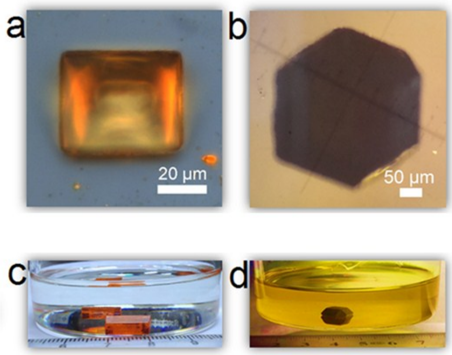

Fig. S1 Optical microscope image of small a) $MAPbBr_3$ and b) $MAPbI_3$ single crystals. Photographs of bulk c) $MAPbBr_3$ and d) $MAPbI_3$ single crystals.

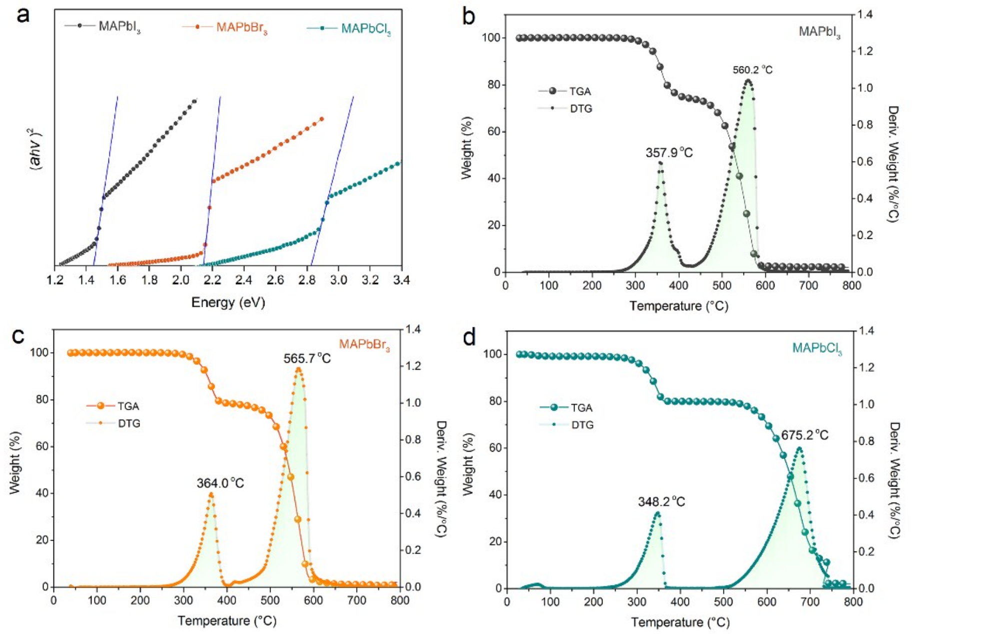

Fig. S2 a) $(\alpha h\nu)^2$ versus hν Tauc plots of $MAPbX_3$ (X = I, Br or Cl) single crystals. TGA and DTG curves of b) $MAPbI_3$, c) $MAPbBr_3$ and d) $MAPbCl_3$ single crystals.

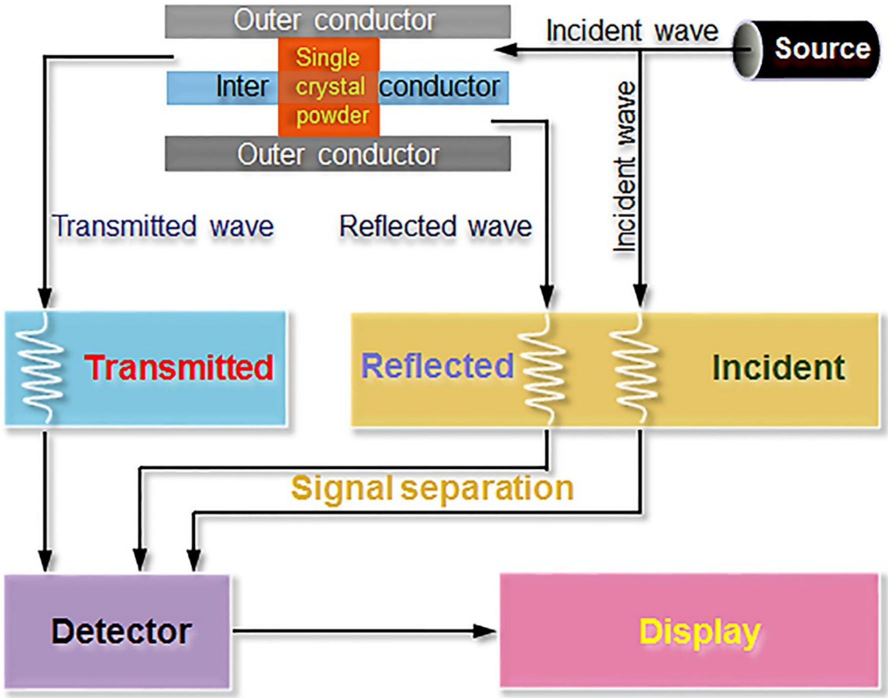

Fig. S3 Schematic drawing of the experimental set-up of the vector network analyzer for microwave absorption measurement.

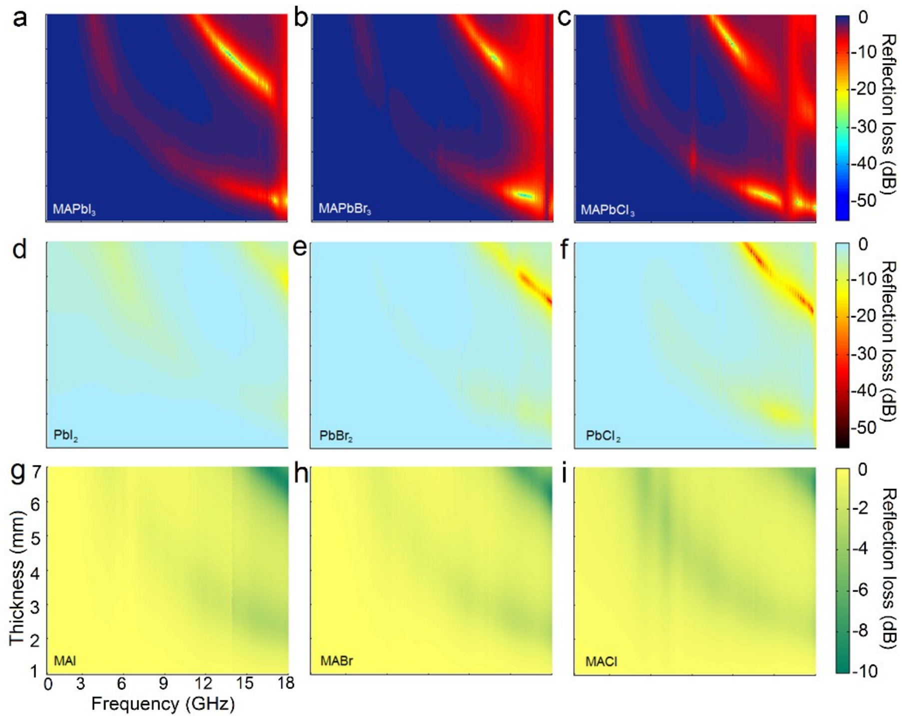

Fig. S4 2D color plots of numerical simulated reflection loss versus thickness as a function of frequency: a) $MAPbI_3$, b) $MAPbBr_3$, c) $MAPbCl_3$, d) PbI_2, e) $PbBr_2$, f) $PbCl_2$, g) MAI, h) MABr and i) MACl samples.

Table S1 The optimal microwave absorption parameters of these measured samples as a function of large thickness.

Samples	Frequency (GHz)	Thickness (mm)	Reflection loss (dB)
$MAPbI_3$	13.80	5.72	-41.66
$MAPbBr_3$	13.63	5.77	-35.07
$MAPbCl_3$	11.00	7.00	-19.42
PbI_2	18.00	5.84	-15.92
$PbBr_2$	17.91	5.26	-49.11
$PbCl_2$	17.65	5.06	-52.47
MAI	16.77	6.99	-9.20
MABr	18.00	6.21	-9.08
MACl	18.00	6.55	-8.23
Paraffin	17.91	6.99	-3.04

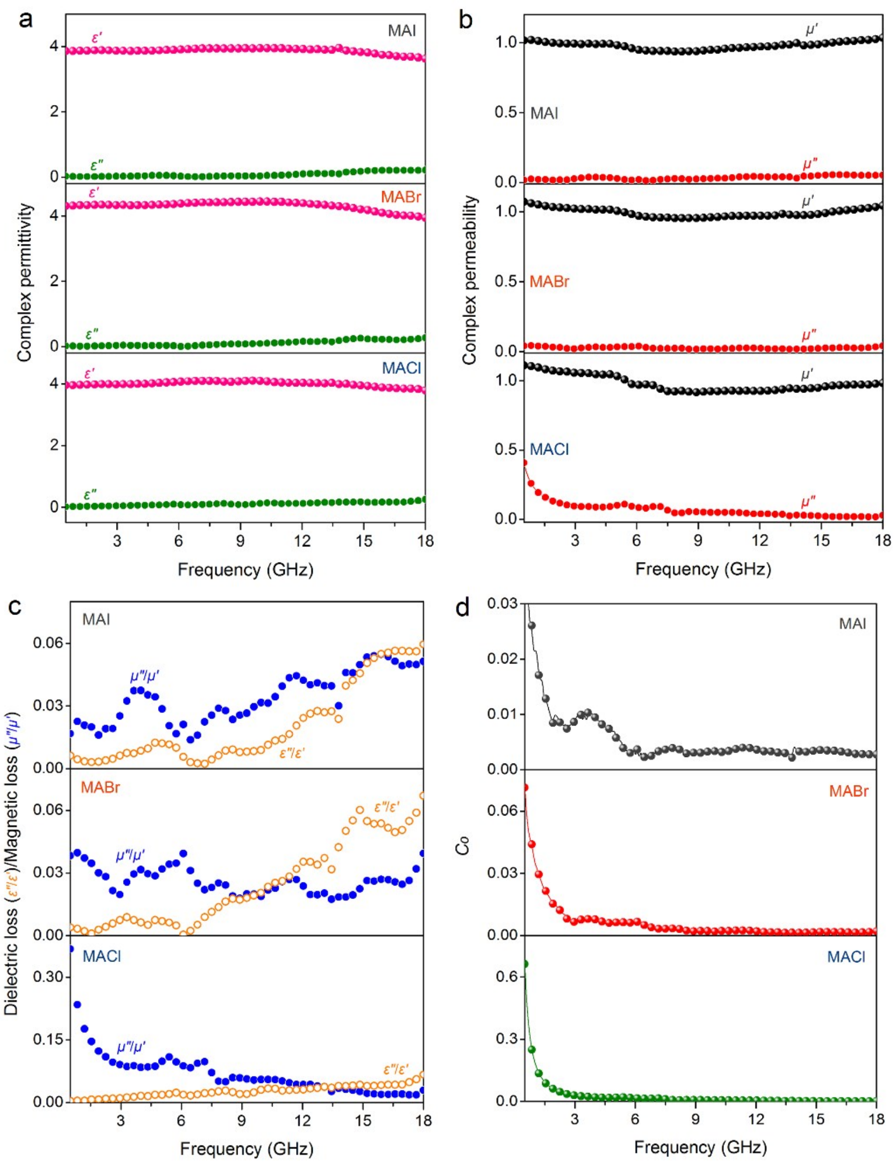

Fig. S5 a) Complex permittivity (ε' and ε''), b) complex permeability (μ' and μ''), c) dielectric loss/magnetic loss and d) *Co* ($Co = \mu''(\mu')^{-2}f^{-1}$) curves of PbX_2 (X = I, Br or Cl) samples.

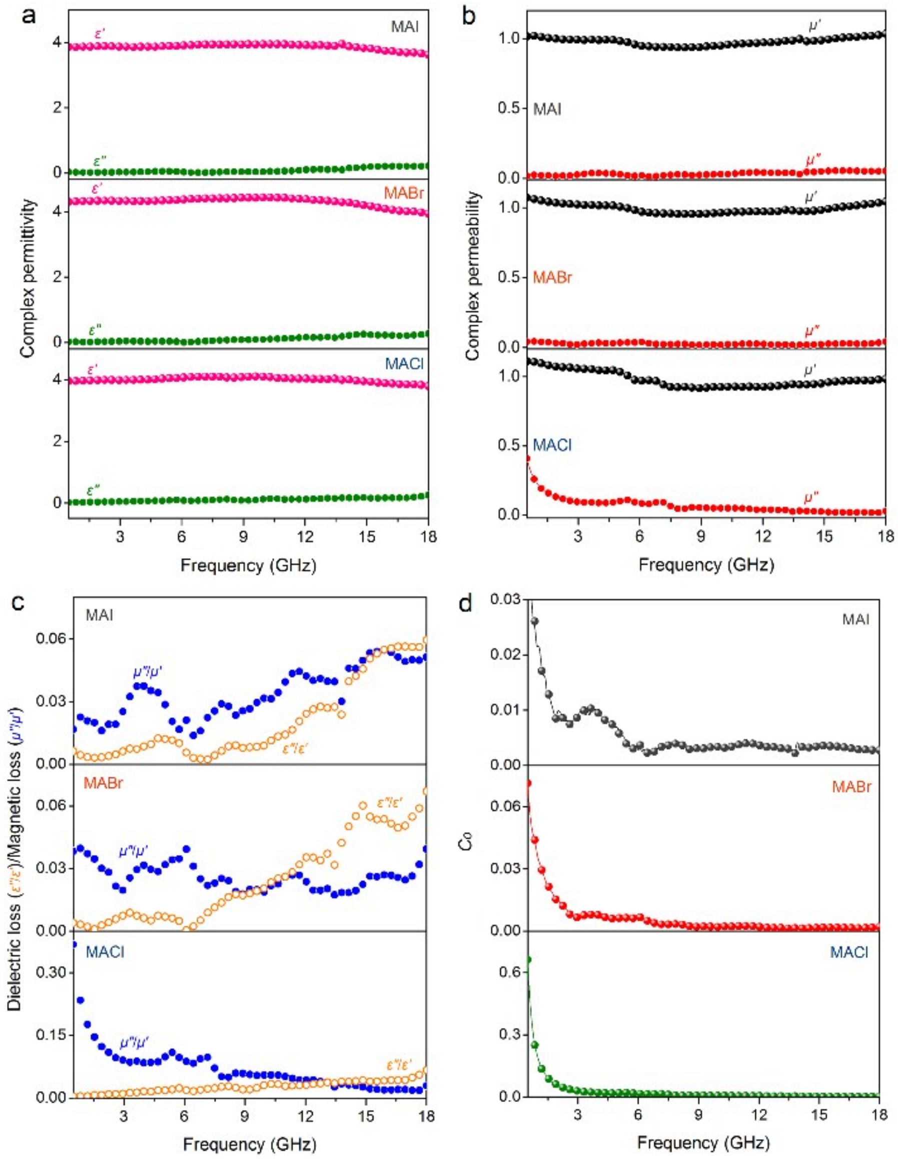

Fig. S6 a) Complex permittivity (ε' and ε''), b) complex permeability (μ' and μ''), c) dielectric loss/magnetic loss and d) C_o ($C_o = \mu''(\mu')^{-2}f^{-1}$) curves of MAX (X = I, Br or Cl) samples.

Table S2 The optimal microwave absorption parameters of these measured samples as a function of stored time in N_2.

Samples	Days	Frequency (GHz)	Thickness (mm)	Reflection loss (dB)
	0	16.77	1.62	55.23
	30	13.45	2.09	46.89
$MAPbI_3$	90	15.2	1.88	43.77
	120	18	1.45	37.03
	180	17.04	1.6	26.51
	0	15.46	1.76	54.7
	30	15.46	1.81	44.11
$MAPbBr_3$	90	15.99	1.67	37.92
	120	16.25	1	36.67
	180	17.04	1.58	24.84
	0	13.54	1.95	46.44
	30	17.48	1.55	43.68
$MAPbCl_3$	90	16.6	1.55	41.75
	120	12.49	2.11	38.87
	180	17.04	1.58	24.84

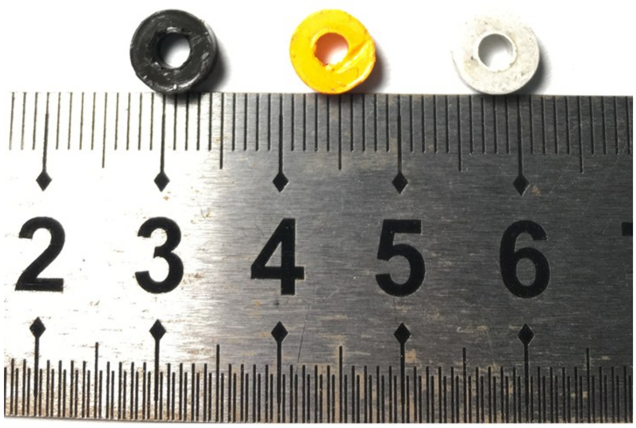

Fig. S7 Photographs of $MAPbI_3$, $MAPbBr_3$ and $MAPbCl_3$ crystal samples stored in N_2 for 180 days.