Supporting Information

Thermo-Enhanced Upconversion Luminescence in Inert-Core/Active-Shell UCNPs: Inert-Core Matters

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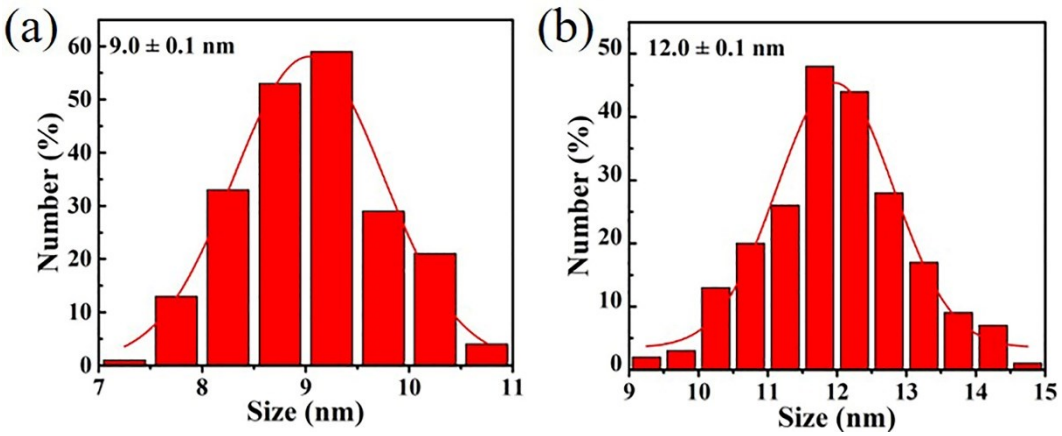

Fig. S1 The size distributions of (a) $NaGdF_4$ inert-core and (b) $NaGdF_4$@$NaGdF_4$: Yb/Tm inert-core/active-shell UCNPs.

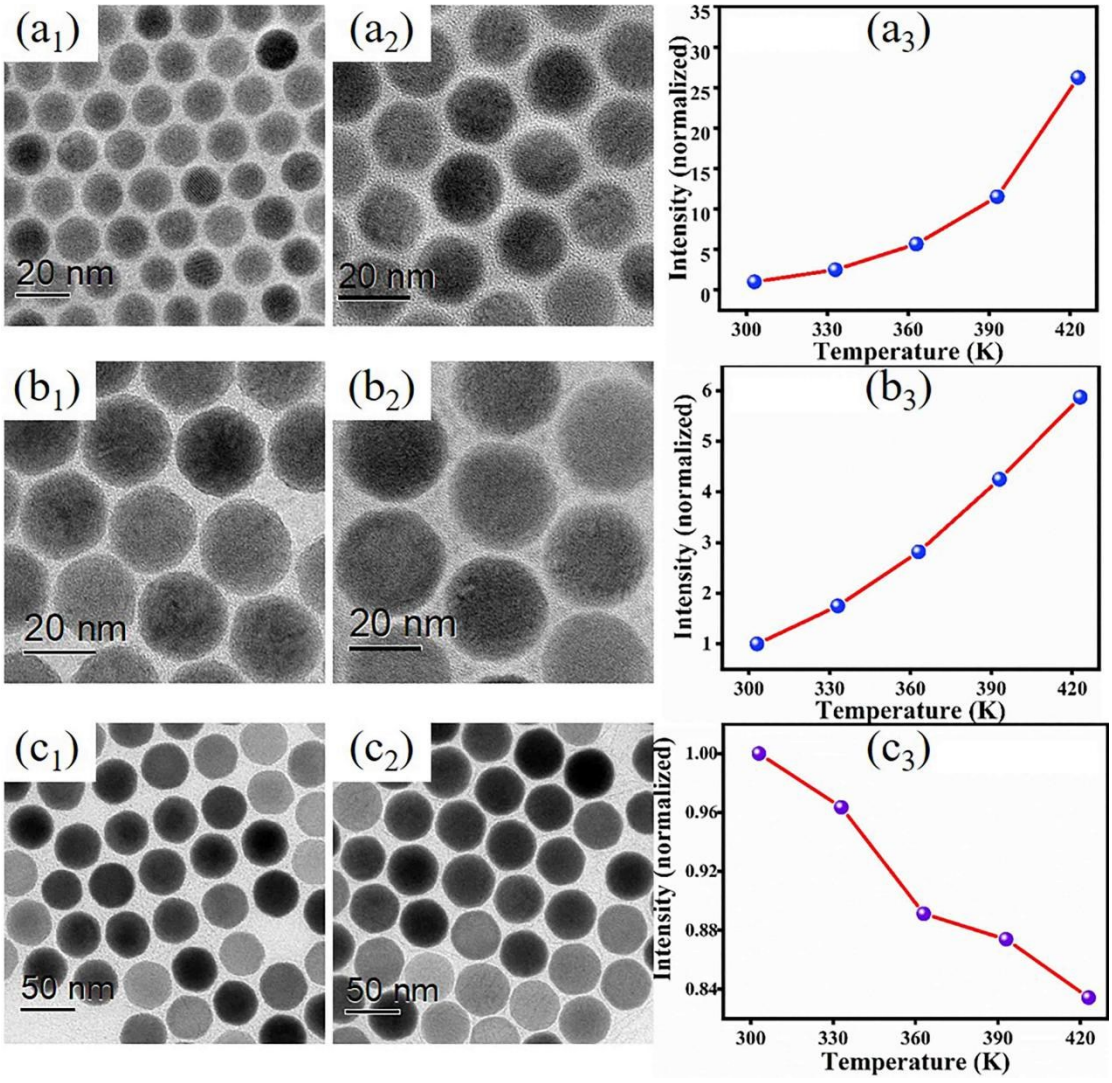

Fig. S2 (a_1-c_1) TEM micrographs of the $NaGdF_4$ inert-core with different sizes about 17 nm, 27

nm, 43 nm, respectively. (a_2-c_2) The corresponding TEM micrographs after coating active-shell (about 1.5 nm thickness). (a_3–c_3) The integrated UCL intensities of $NaGdF_4$@$NaGdF_4$: Yb/Tm (20/1 mol%) UCNPs with different inert-core size.

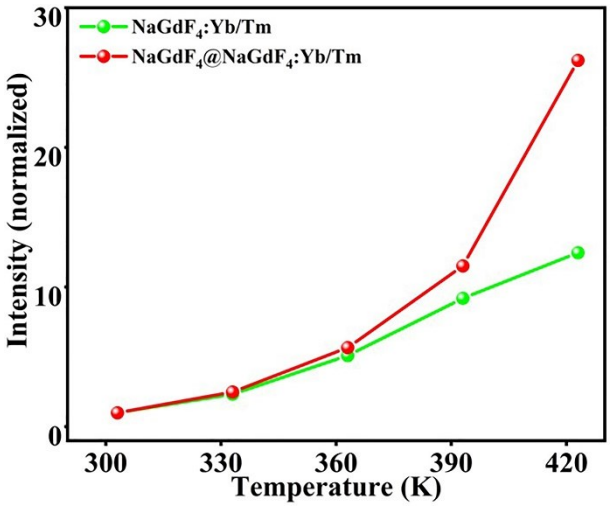

Fig. S3 Temperature-dependent integrated UCL intensities for $NaGdF_4$: Yb/Tm (20/1 mol%, ~12 nm) and $NaGdF_4$@$NaGdF_4$: Yb/Tm (20/1 mol%, ~9@3 nm) UCNPs.

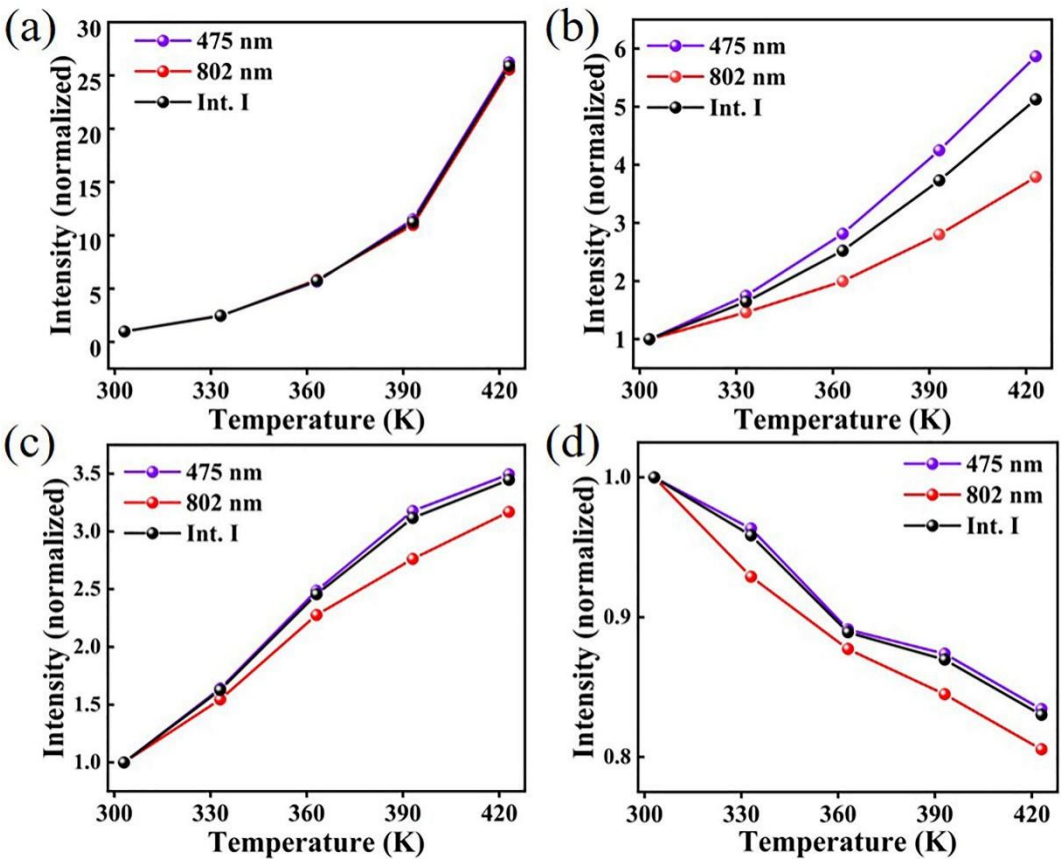

Fig. S4 Temperature-dependent integrated UCL intensities including 475 nm and 802 nm for $NaGdF_4$@$NaGdF_4$: Yb/Tm (20/1 mol%) UCNPs with different sizes of (a) ~9@3 nm, (b) ~17@3 nm, (c) ~27@3 nm (d) ~43@3 nm.

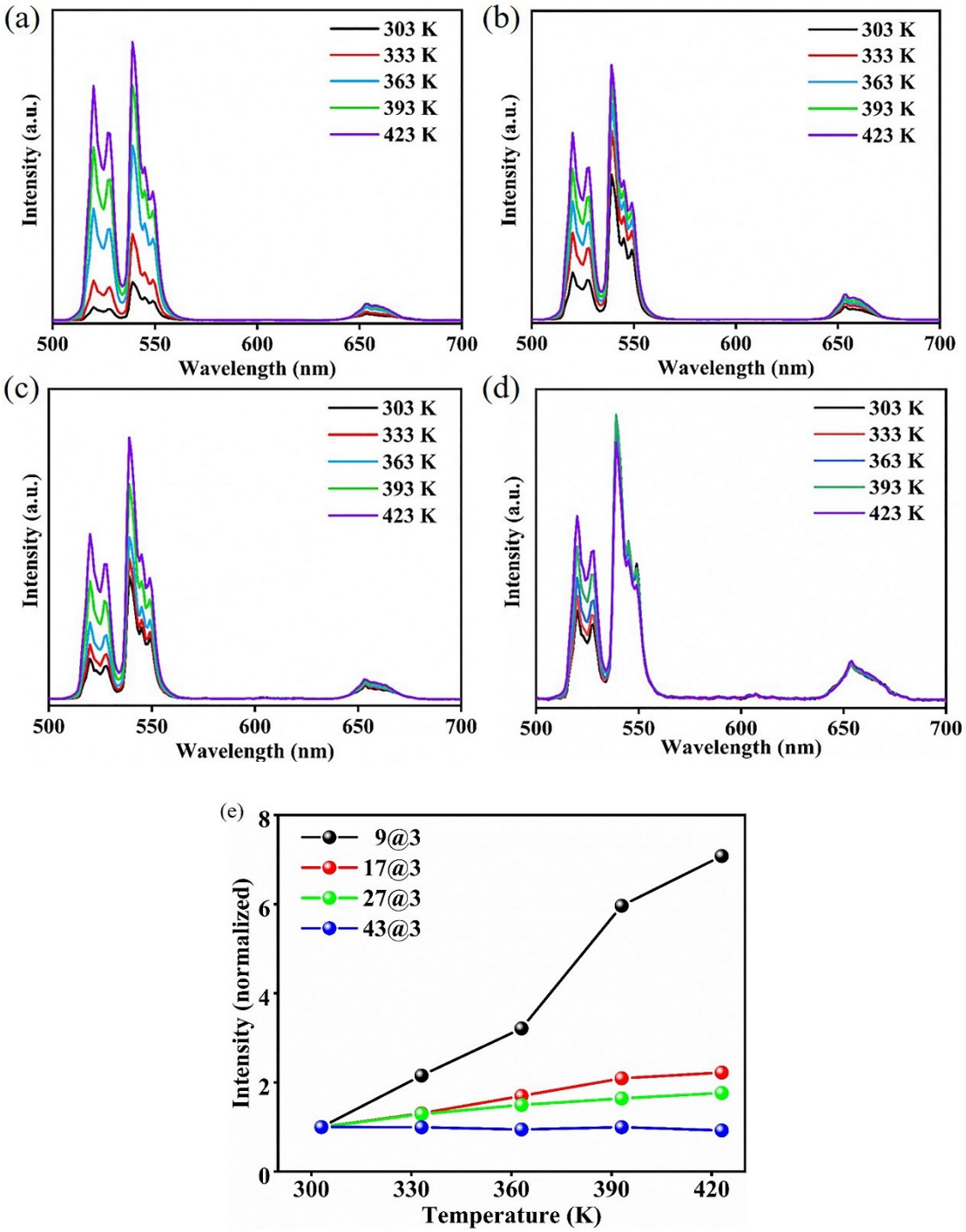

Fig. S5 Temperature-dependent UCL emission spectra (λ_{ex} = 980 nm) of $NaGdF_4$@$NaGdF_4$: Yb/Er (20/2 mol%) inert-core/active shell UCNPs with different sizes of (a) ~9@3 nm, (b) ~17@3 nm, (c) ~27@3 nm (d) ~43@3 nm. (e) Temperature-dependent integrated UCL intensities for $NaGdF_4$@$NaGdF_4$: Yb/Er (20/2 mol%) UCNPs with different inert-core sizes.

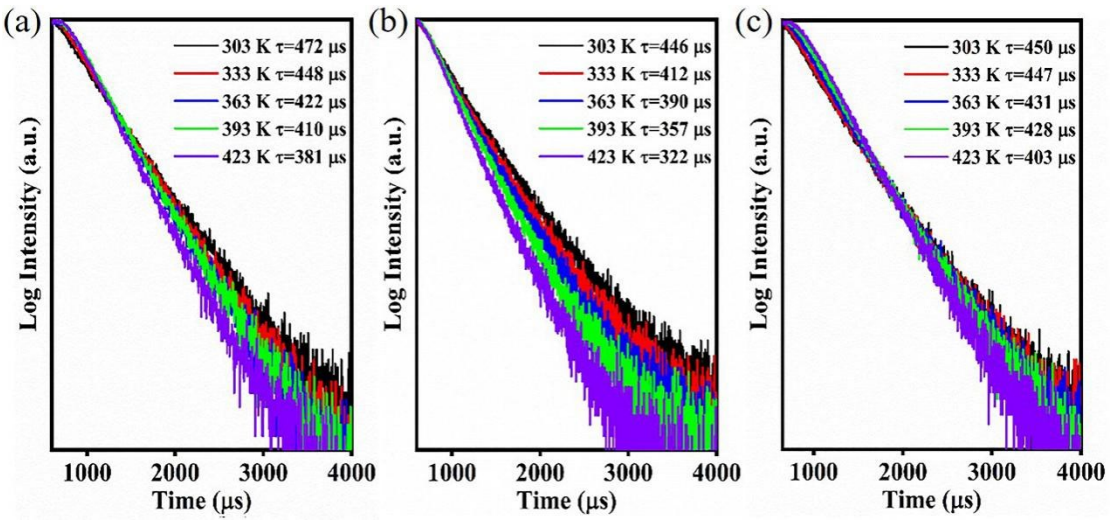

Fig. S6 Temperature-dependent decay lifetimes for $^1G_4$ excited state of Tm^{3+} in $NaGdF_4$@$NaGdF_4$: Yb/Tm (20/1 mol%) UCNPs with different sizes of (a) ~9@3 nm, (b) ~17@3 nm and (c) ~43@3 nm.

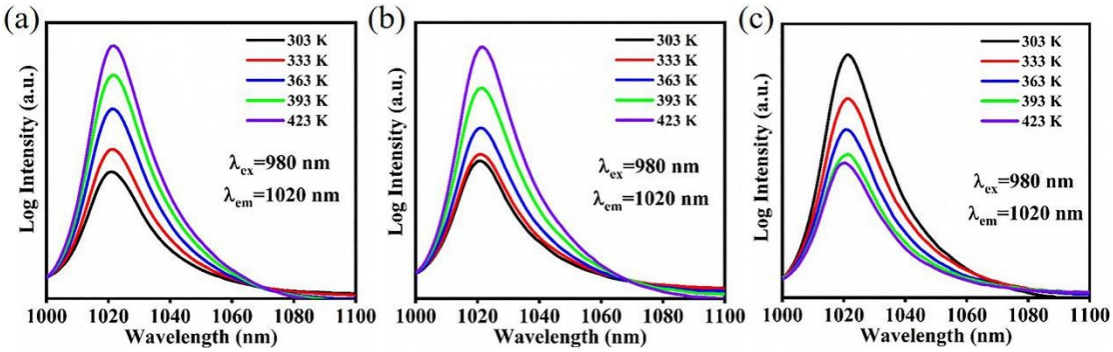

Fig. S7 Temperature-dependence DCL emission spectra of $NaGdF_4$@$NaGdF_4$: Yb/Tm (20/1 mol%) UCNPs with different sizes of (a) ~9@3 nm, (b) ~17@3 nm and (c) ~43@3 nm.

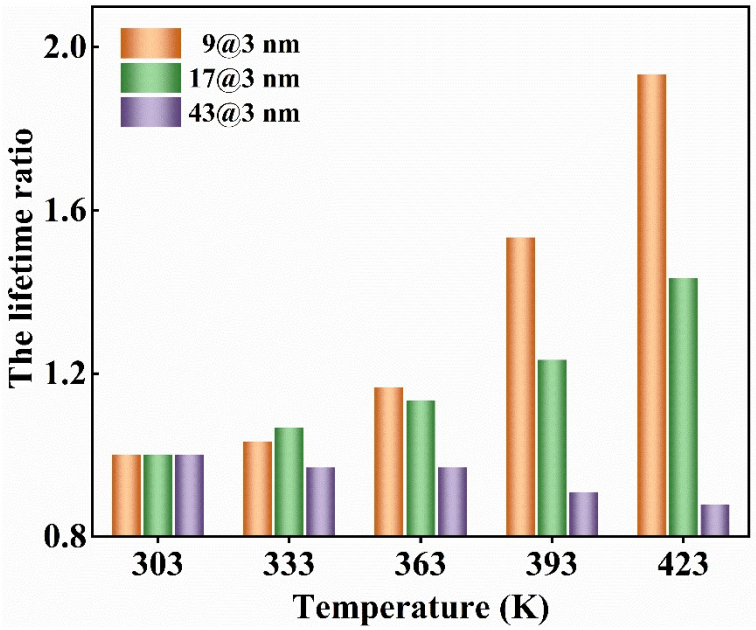

Fig. S8 The lifetime ratio for $^2F_{5/2}$ excited state of Yb^{3+} in $NaGdF_4$@$NaGdF_4$: Yb/Tm (20/1 mol%) UCNPs of different sizes.

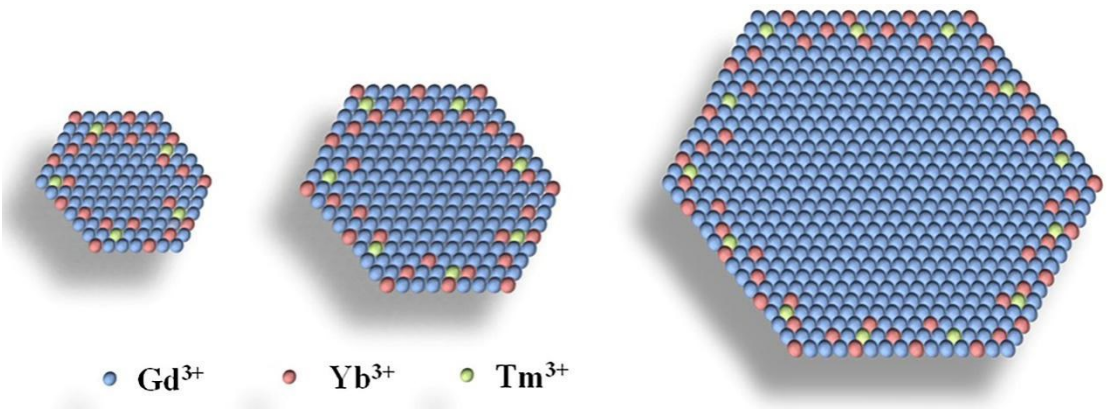

Fig. S9 Simulation distribution diagram of rare earth ion in the inert-core/active-shell structure with a certain thickness of shell.

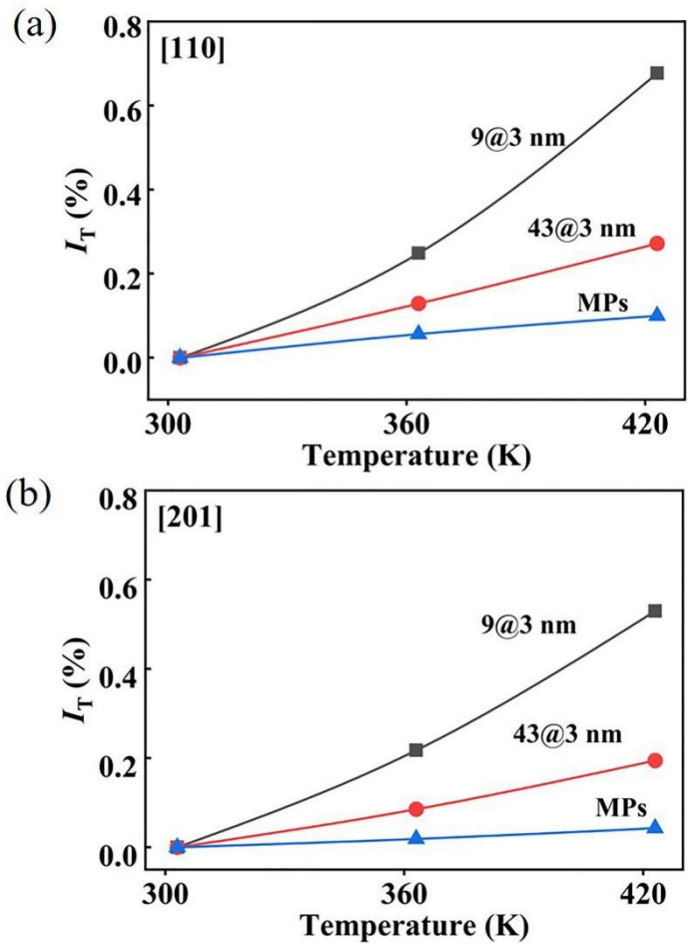

Fig. S10 Plots of the temperature-dependence of the interplanar spacing expansion factor I_T for the (110) and (201) planes of the samples.