Electronic Supplementary Material (ESI) for RSC Advances.

Phonon confinement and particle size effect on the low-frequency Raman mode of Aurivillius phase $Bi_4Ti_3O_{12}$ powders

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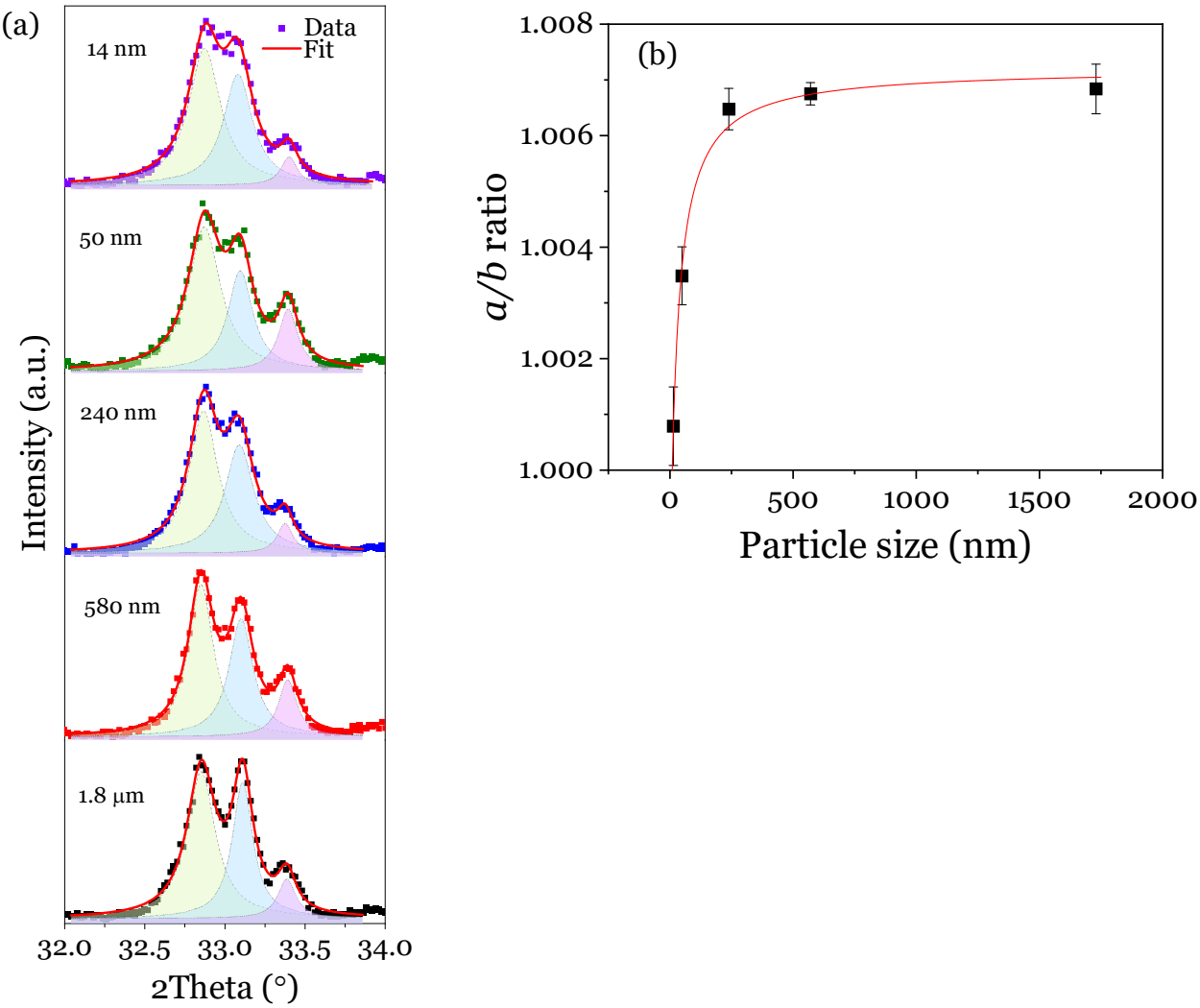


Fig. S1: (a) Expanded view and Lorenztian peak fit of the diffraction line at $2\theta = 33°$; and (b) size dependent orthorhombic distortion (i.e. a/b ratio) vs. particle size x. The experimental data were fitted according to Eq. 2 of Ishikawa et al [1].

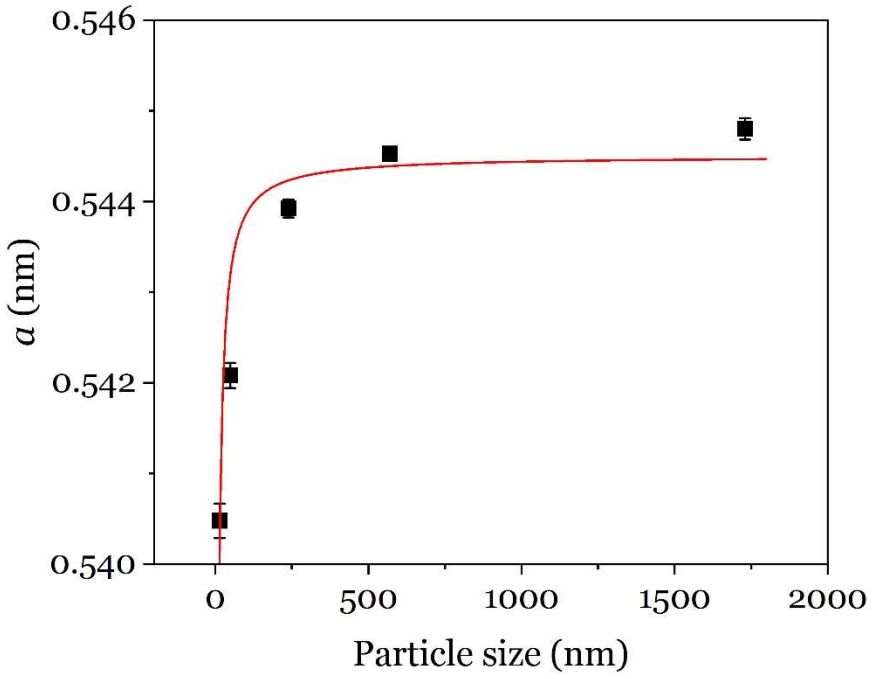
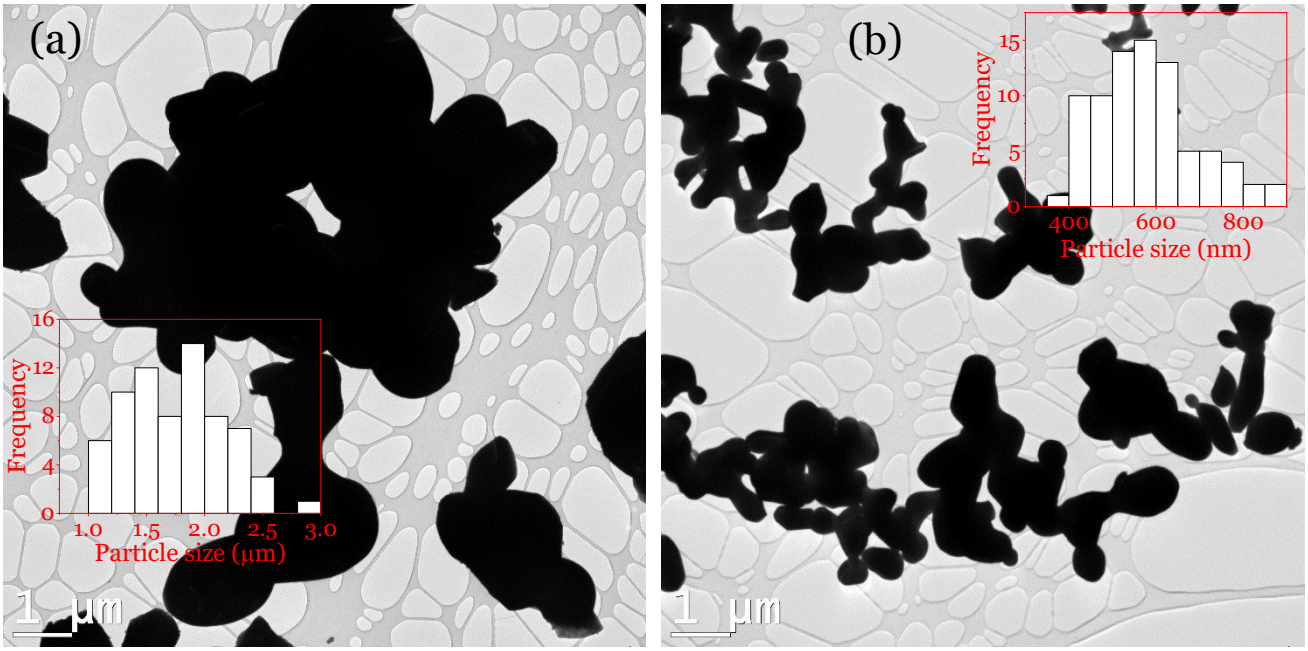


Fig. S2: The variation of the lattice parameter *a* with the particle size.



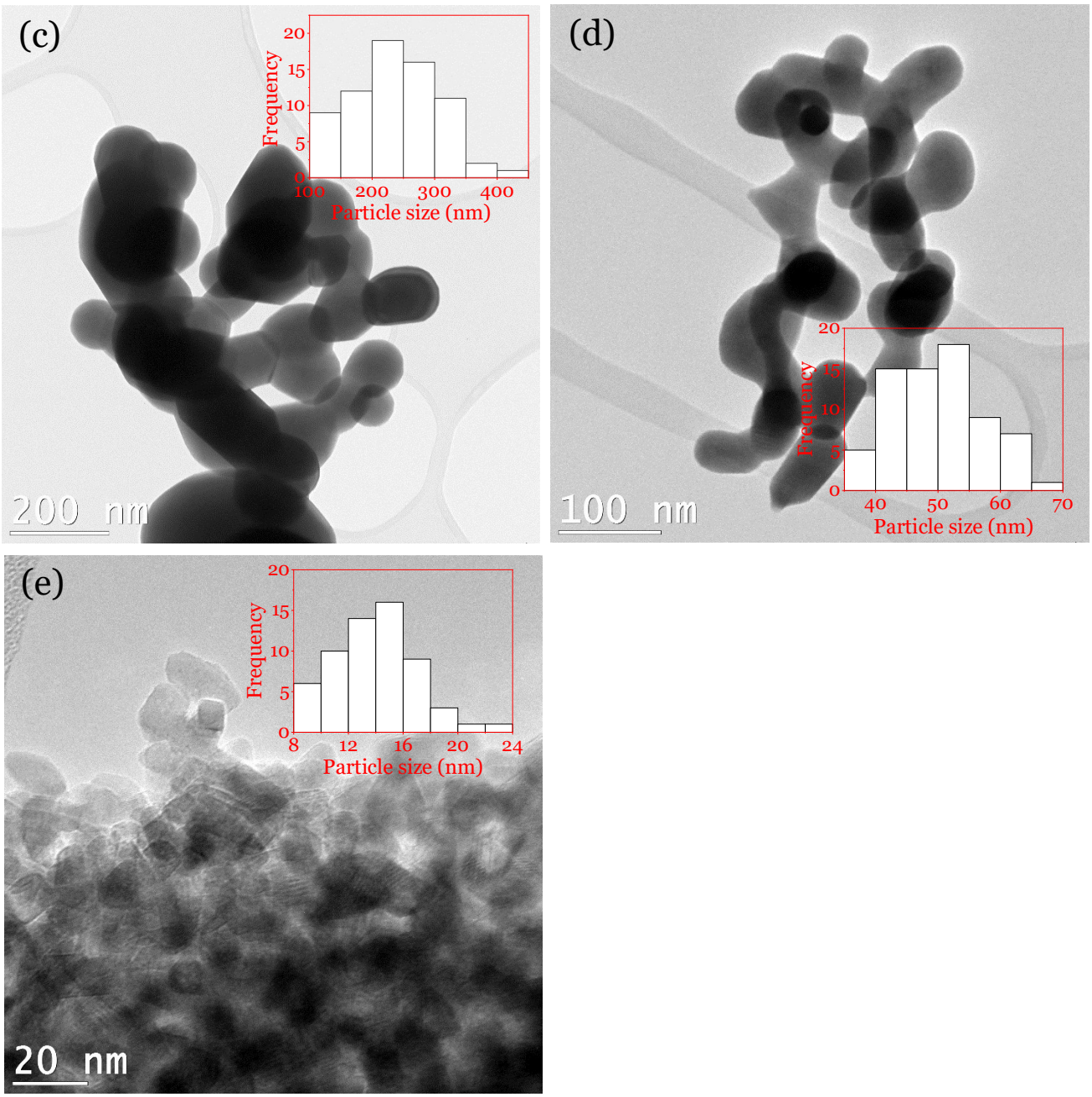
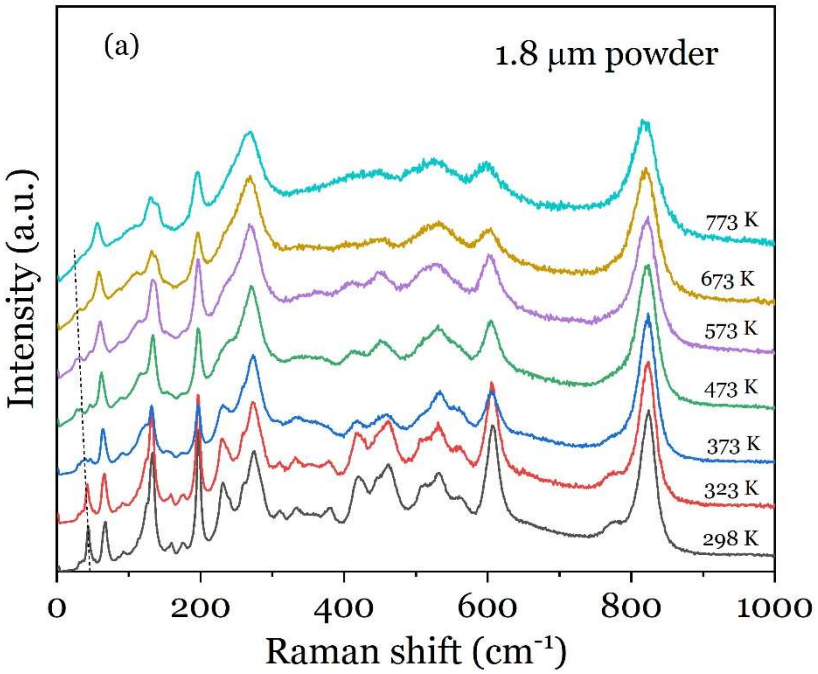
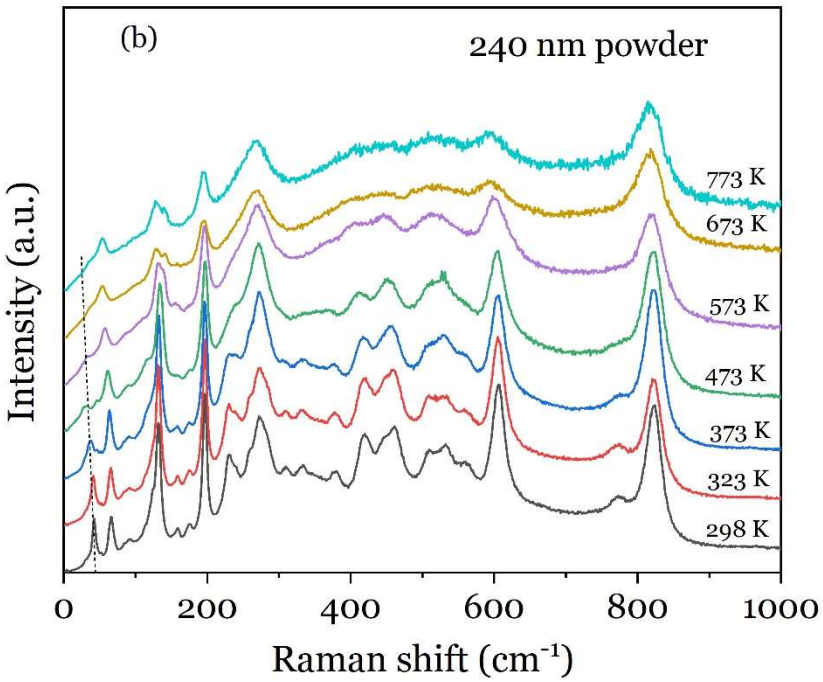


Fig. S3: TEM images of the (a) 1.8 μm (b) 580 nm (c) 240 nm (d) 50 nm and (e) 14 nm bismuth titanate powders. Insets are the histogram reflecting the particle size distribution of the powders.


(a)
1.8 μm powder
Intensity (a.u.)
773 K
673 K
573 K
473 K
373 K
323 K
298 K
0
200
400
600
800
1000
Raman shift (cm-1)


(b)
240 nm powder
Intensity (a.u.)
773 K
673 K
573 K
473 K
373 K
323 K
298 K
0
200
400
600
800
1000
Raman shift (cm-1)

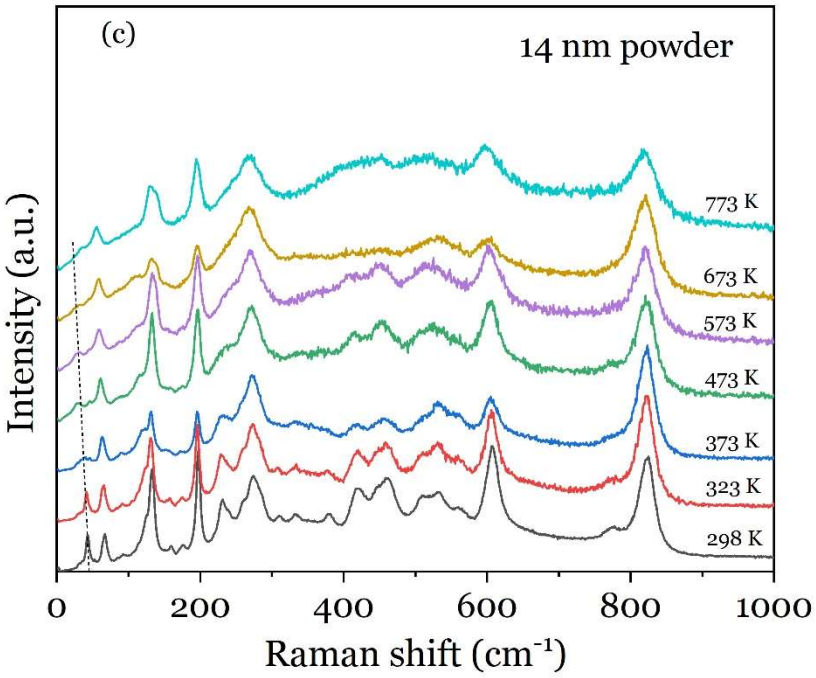


Fig. S4: Raman spectra of the (a) 1.8 μm, (b) 240 nm, and (c) 14 nm bismuth titanate powders as a function of temperature. All the spectra are corrected with the Bose-Einstein occupation factor.

References

[1] K. Ishikawa, T. Nomura, N. Okada, K. Takada, Size effect on the phase transition in $PbTiO_3$ fine particles, Jpn. J. Appl. Phys., 35 (1996) 5196-5198.