https://doi.org/10.1007/s11467-023-1301-7

RESEARCH ARTICLE

Freeze-drying assisted liquid exfoliation of $BiFeO_3$ for pressure sensing

Yuping Li, Mengwei Dong, Xuejie Zou, Jinhao Zhang, Jian Zhang†, Xiao Huang‡

Key Laboratory of Flexible Electronics (KLOFE) & Institute of Advanced Materials (IAM), Jiangsu National Synergetic Innovation Center for Advanced Materials (SICAM), Nanjing Tech University (NanjingTech), 30 South Puzhu Road, Nanjing 211816, China

Coresponding authors. E-mail: †iamjzhang@njtech.edu.cn, ‡iamxhuang@njtech.edu.cn

Received December 11, 2023; accepted April 24, 2023

Supporting Information

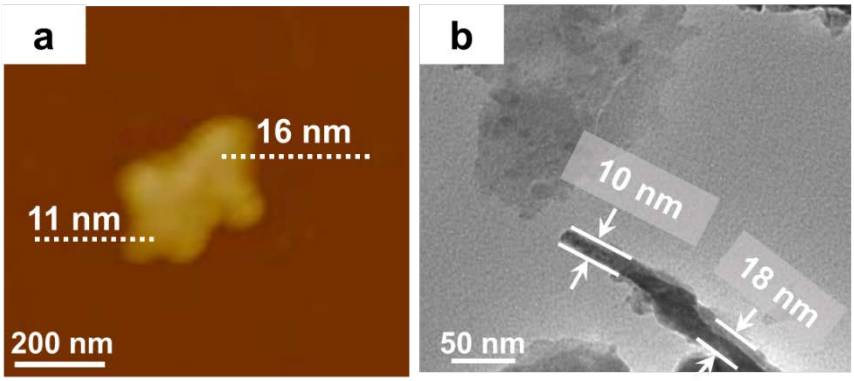

Fig. S1 (a) AFM height image and **(b)** cross-section TEM image of exfoliated $BiFeO_3$ nanoplates.

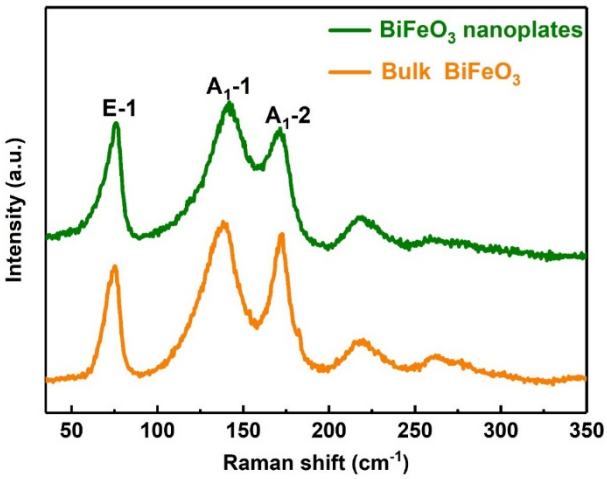

Fig. S2 Raman spectra of bulk $BiFeO_3$ and as-exfoliated thin layer $BiFeO_3$ nanoplates.

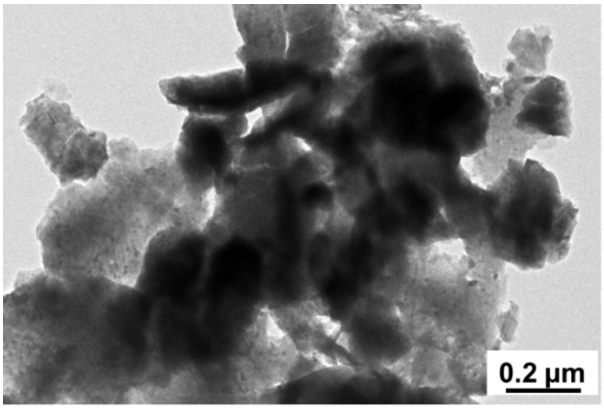

Fig. S3 TEM image of the as-exfoliated $BiFeO_3$ nanoplates without freeze-drying assisted.

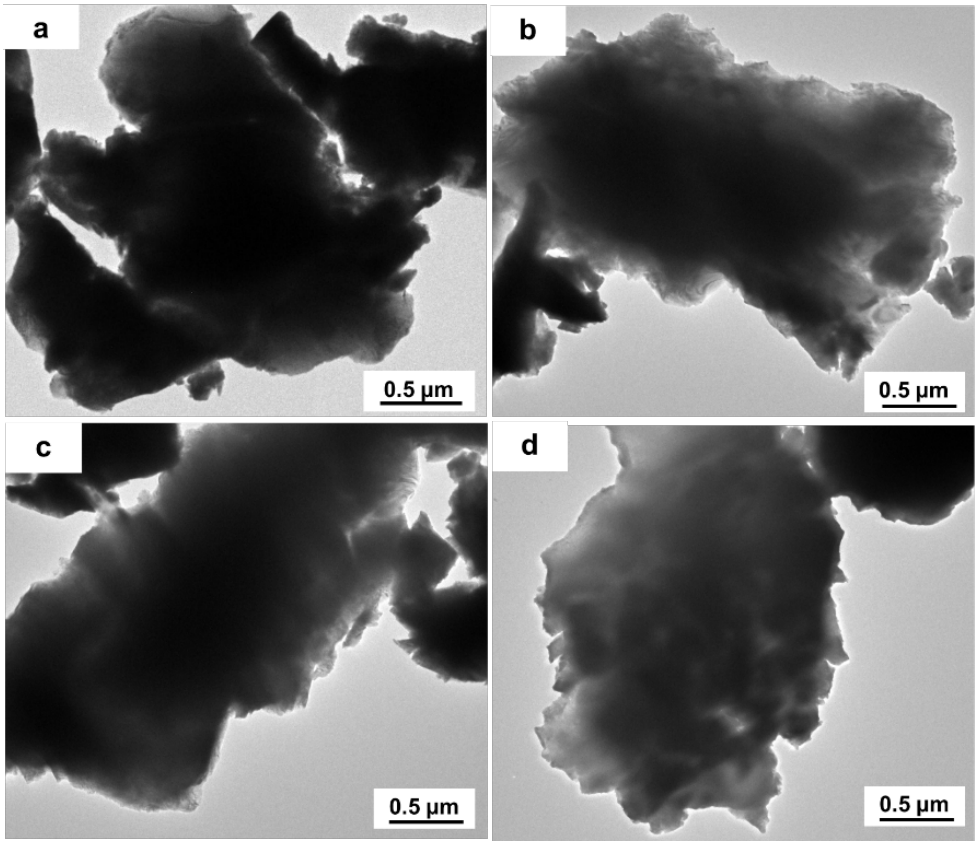

Fig. S4 TEM images of **(a)** bulk $BiFeO_3$ and **(b, c, d)** freeze-dried $BiFeO_3$ in methanol, water, ethanol.

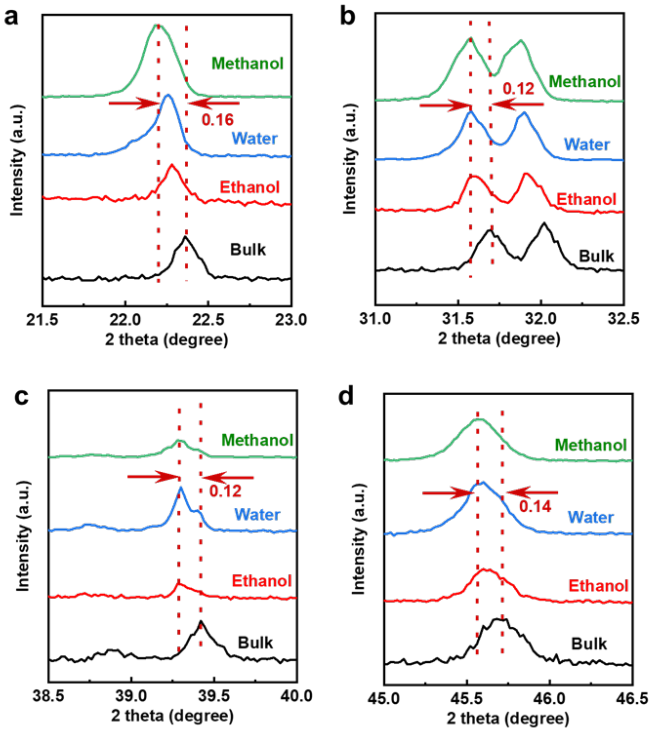

Fig. S5 Enlarged XRD patterns for different angle ranges for bulk $BiFeO_3$ and freeze-dried $BiFeO_3$ in methanol, water, ethanol.

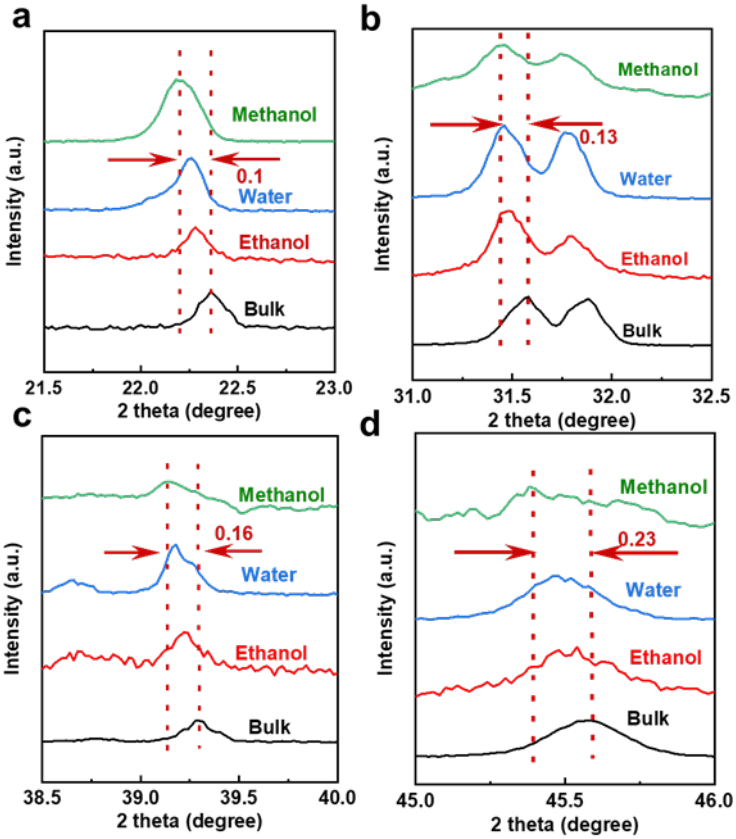

Fig. S6 Enlarged XRD patterns for different angle ranges for bulk $BiFeO_3$ and exfoliated products obtained after ultrasonication in ethanol, water and methanol for 8 h.

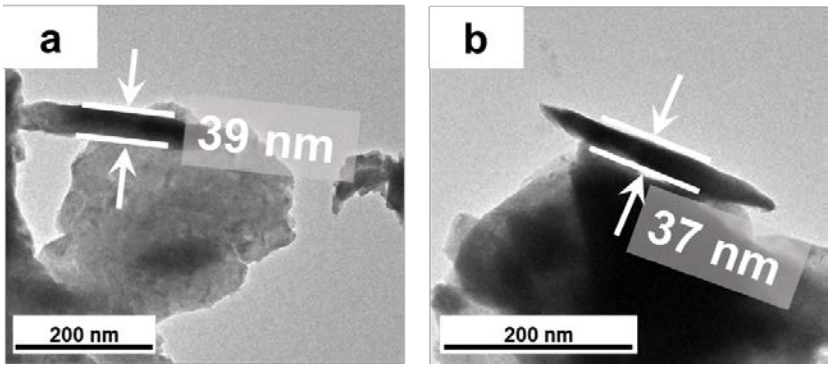

Fig. S7 Cross-section TEM images of $BiFeO_3$ nanoplates obtained after exfoliation in **(a)** ethanol and **(b)** water.

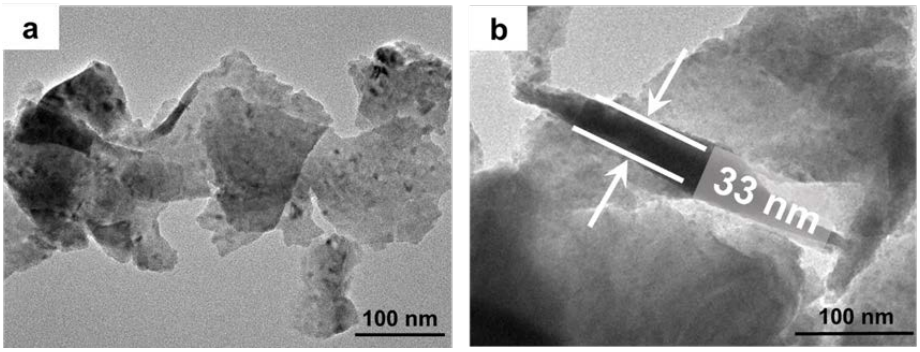

Fig. S8 TEM images of exfoliated $BiFeO_3$ nanoplate by using DMF.

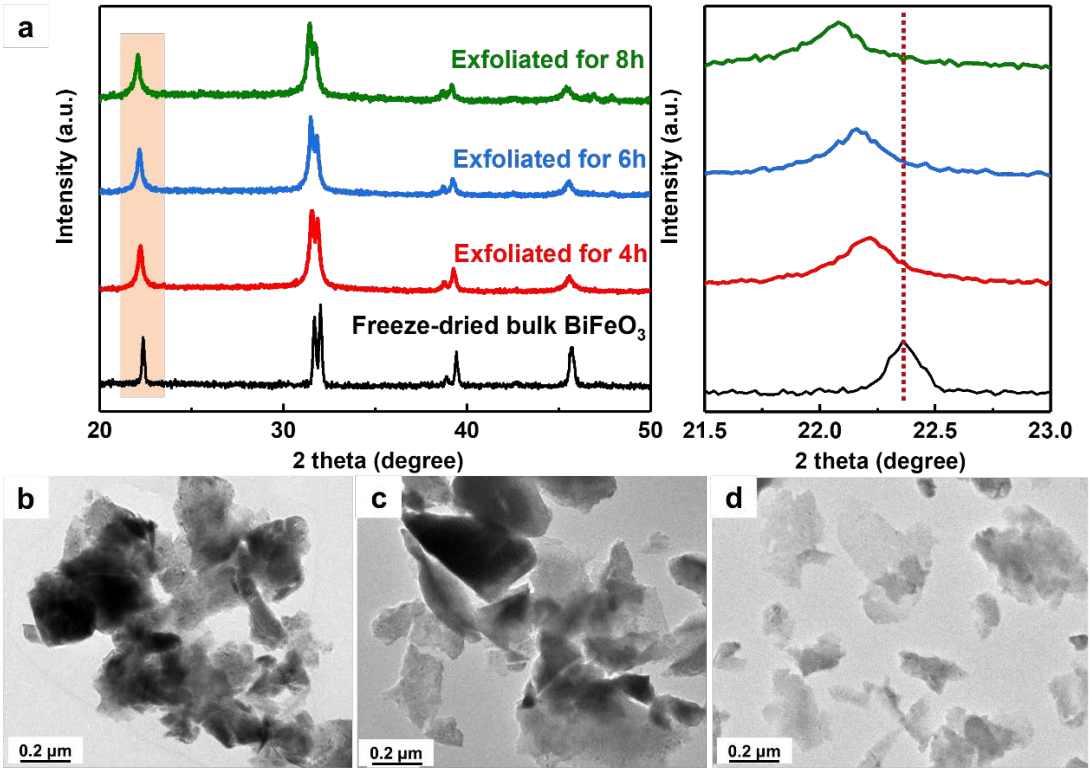

Fig. S9 (a) XRD patterns as-exfoliated $BiFeO_3$ nanoplates for different ultrasonication time and bulk $BiFeO_3$, TEM images **(b, c, d)** of as-exfoliated $BiFeO_3$ nanoplates for (b) 4 h, (c) 6 h and (d) 8 h.

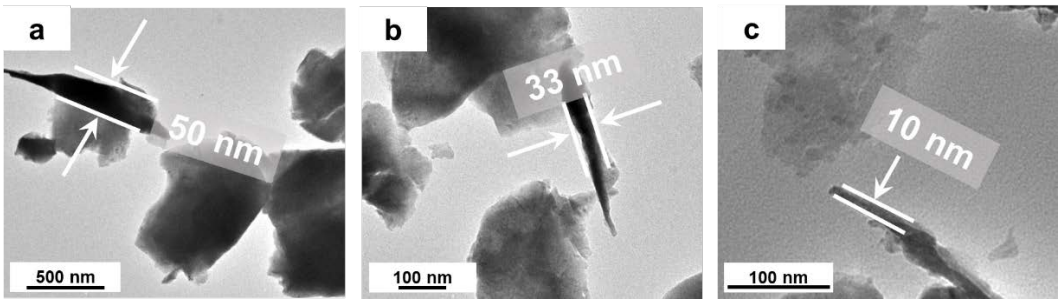

Fig. S10 Cross-section TEM images of liquid exfoliated $BiFeO_3$ nanoplates for **(a)** 4 h, **(b)** 6 h and **(c)** 8 h.

Table S1 The d33 values of bulk and exfoliated $BiFeO_3$.

	Bulk $BiFeO_3$	Exfoliated $BiFeO_3$ nanoplates
d33 (pC/N)	1.77	5.6