**Supplementary Material**

**Formulation and rheological characterization of piezoelectric nanofluid**

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**S.1. Synthesis of barium titanate (BaTiO3)**

First, the precursor materials (Ba(OH)2.8H2O from Riedel-De Haen, Germany and TiO2 anatase from Sigma-Aldrich) were mechanically activated by, separately, milling for 5 h at 500 rpm using planetary ball mill (Changsha Tianchuang Powder Technology Co., Ltd., China) at ambient temperature. Stoichiometric amounts of dry activated precursor materials were transferred into 50–mL agate jars and mixed by ball milling for 10 h at 500 rpm using agate balls (Ø 4 and 6 mm). The mass ratio of solid materials to balls was kept at 1:10. The mixed materials were transferred in ceramic boat crucibles and calcined at 800 °C for 3 h (heating rate of 5 ºC min–1) under air in a tube furnace. The as–synthesized material was left to naturally cool down to room temperature.

**S.2. Characterization of barium titanate**

The crystallinity and purity of the as–synthesized barium titanates have been characterized by Raman spectrometer (DXR) from ThermoFisher Scientific (at 532 nm) and X-ray diffractometer from Panalytical Empyrean. Figure S1 displays the Raman spectra of precursor materials (Ba(OH)2.8H2O and TiO2 anatase) and the as–synthesized BaTiO3. The most characteristic bands of BaTiO3 are identified at 525, 305 and 260 nm in agreement with previous reported values [1]. In addition, traces of precursor materials are likely to exist with BaTiO3 as indicated from the bands at 140 nm. Further identification of the as–synthesized material is acquired from XRD as depicted in Figure S2. Featured diffraction peaks for BaTiO3 are positioned at 2θ = 22º, 32º, 38º and 57º in accordance with the reference lines (ICDD: 01–074–1960). Peaks from the precursor materials can be detected indicating the existence of trace amounts of unreacted materials.

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**Figure S1**. Raman spectra of the precursor materials (Ba(OH)2.8H2O and TiO2 anatase) and the as–prepared BaTiO3.



**Figure S2.** XRD diffraction pattern of the as–prepared BaTiO3 and the reference lines of TiO2 anatase (ICDD: 01–074–1960) and BaTiO3 (ICDD: 98–009–6946).

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**Figure S3.** Schematic representation for the customized cell used in rheo–electrical (impedance spectroscopy and open circuit potential) measurements.



**Figure S4.** Variation of the elastic (*G*′) and the viscous (*G*″) moduli with the angular frequency (ω) at 25 ºC in the LVR for the CNTs dispersions at various contents (*C*CNT) in weight per cent (wt.%).



**Figure S5.** Variation of the viscosity (η) with the shear rate () at 25 ºC for selected CNTs dispersions. The closed and open symbols present, respectively, the upscan (→) and downscan (←) modes of shear rate.

**S.3. The equivalent circuit**

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**Figure S6.** (a) strain sweep, (b) frequency sweep, and (d) flow curves of BTO dispersions in PDMS at 25 ºC.

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**Figure S7.** Variation of the viscosity (η) with the shear rate () at 25 ºC for (a) BaTiO3, (b) PVdF and (c) hybrid BaTiO3–PVdF suspensions in 1 wt.% CNTs/PDMS. *C*BTO and *C*PVdF are the weight per cents of BaTiO3 and PVdF, respectively.

**References**

[1] H. Hayashi, T. Nakamura, T. Ebina, J. Phys. Chem. Solids74 (2013) 957. <https://doi.org/10.1016/j.jpcs.2013.02.010>