**Supporting Information**

**Promising aqueous dispersions of carbon black for semisolid flow battery application**

Mentallah Meslam1, Ahmed A. Elzatahry1, Mohamed Youssry2\*

1 Materials Science and Technology Program, College of Arts and Sciences, Qatar University, Doha, 2713, Qatar

2 Chemistry Program, Department of Chemistry and Earth Sciences, College of Arts and Sciences, Qatar University, Doha 2713, Qatar

**\*Corresponding author:**

Tel: +974 44036541, E-mail: [myoussry@qu.edu.qa](mailto:myoussry@qu.edu.qa)

**S.1. Synthesis and characterization of sodium titanate (Na2Ti3O7)**

**S.1.1. Synthesis method of sodium titanate**

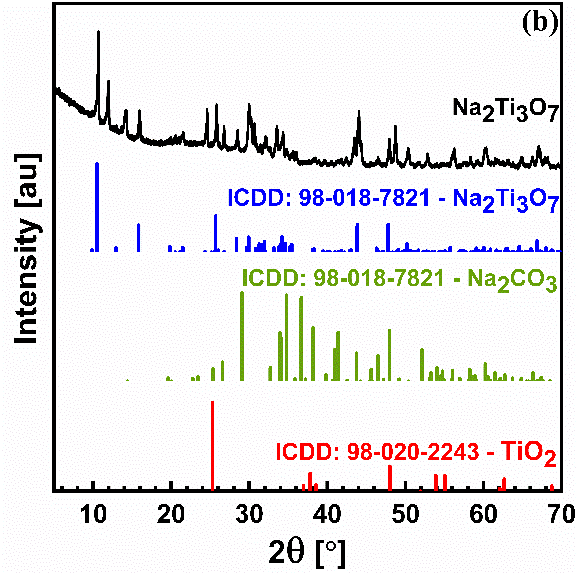
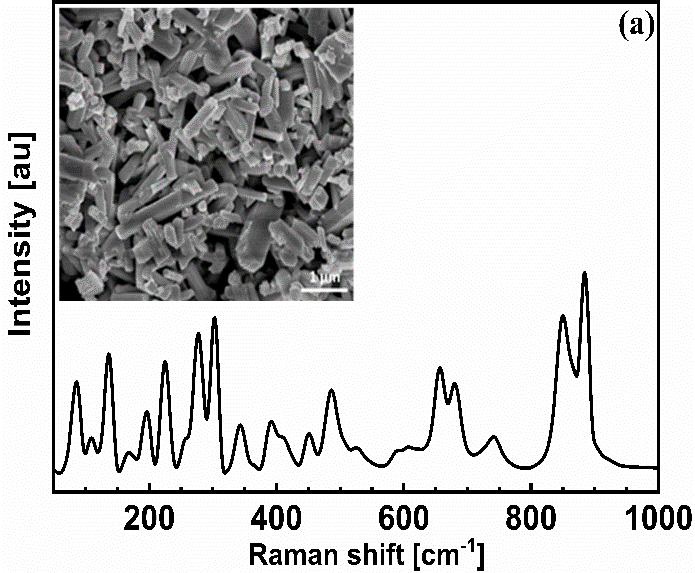
Synthesis of sodium titanate Na2Ti3O7 (NTO), as anode material, was done by dry ball milling method (as detailed elsewhere [1]) using a ball-mill from Changsha Tianchuang Powder Technology Co., Ltd, China, equipped by agate jars (50 mL) and balls (diameter = 6 mm). Weighted amounts of Na2CO3 anhydrous (1 mole) and TiO2 anatase (3 mole) were mechanically activated by milling for 5 h at 500 rpm. The activated mixture were then calcined at 800 °C for 3 h (heating rate = 5 °C min–1) in a tube furnace under air. The synthesized titanates were left to naturally cool down to room temperature before grinding by ceramic mortar and pestle.

**S.1.2. Crystallinity of materials**

A Raman spectrometer from ThermoFisher Scientific (DXR), working at excitation wavelength of 532 nm, was used to investigate the degree of graphitization of carbon nanomaterials and characterize the as-synthesized sodium titanate. The crystalline structure and purity of the as-synthesized sodium titanate were determined by X-ray diffraction (XRD) (Malvern Panalytical Empyrean X-ray diffractometer, UK)

**S.1.3. Analysis of Raman spectra and XRD of as-synthesized sodium titanates**

The dry ball–mill method has been reported as an optimal approach to synthesize sodium titanates without the implications accompany the solvent–based methods such as hydrothermal method [1]. The crystalline structure and purity of the as-synthesized sodium titanate have been examined by Raman spectroscopy and X-ray diffraction (XRD). The Raman spectrum of the as-synthesized material (Fig. S1-a) is dominant by featured modes at *ca.* 304, 342, 486, 656, 849 and 882 cm−1 which are characteristic modes for layered Na2Ti3O7 phase in agreement with previous reports [1, 2]. Traces of Na2Ti6O13 structure may exist as indicated from the modes at 224 and 278 cm−1. Moreover, no modes have been shown for unreacted precursor materials (TiO2 anatase and Na2CO3).



**Figure S1** (a) Raman spectrum of the as-synthesized Na2Ti3O7. The inset is the scanning electron micrograph of NTO (scale bar is 1 μm), and (b) XRD diffraction pattern of Na2Ti3O7. The colored lines are the reference diffraction lines for the synthesized Na2Ti3O7, and precursor materials (TiO2 anatase and Na2CO3 anhydrous).

Figure S1-b displays the XRD diffraction pattern of the as-synthesized material and the reference lines for Na2Ti3O7 and precursor materials. No diffraction peaks of unreacted starting materials have been detected implying the reaction completion and formation of sodium titanate. The pattern is consistent with that of the reference Na2T3O7 (ICDD: 98-018-7821) with characteristic peaks at 2θ = 10.7◦ (100), 16◦ (101), 25.8◦ (110), and 44◦ (104). Other diffraction peaks (at 2θ = 12◦, 14◦, 26.6◦) are observed in the pattern indicating the coexistence of trace amount of Na2Ti6O13 in agreement with the Raman spectrum. The morphology of the as-synthesized material is examined by SEM as depicted in the micrograph in the inset of Fig. S1-a. The material is polydisperse nanorods with an average length of *ca*. 700 nm–1.1 μm and width of few hundred nanometers.

Diagram

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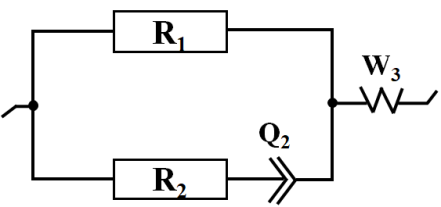
**Figure S2** Customized cell (copper parallel plates) for the rheo-impedance measurements.

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**Figure S3** Strain sweep results for dilute dispersions of carbon black (KB) in the aqueous electrolyte.

**S.2. The impedance spectra and the equivalent circuit**

The EIS data were collected by Squidstat User Interface (Admiral Instruments, USA) and converted by model by an equivalent circuit (Fig. S4) using EC–Lab® software (Biologic, France). The circuit comprises of an electronic (R1) and ionic (R2) resistors in parallel. The ionic resistor is in series with non-ideal capacitive element (Q2) and a Warburg element (W3).

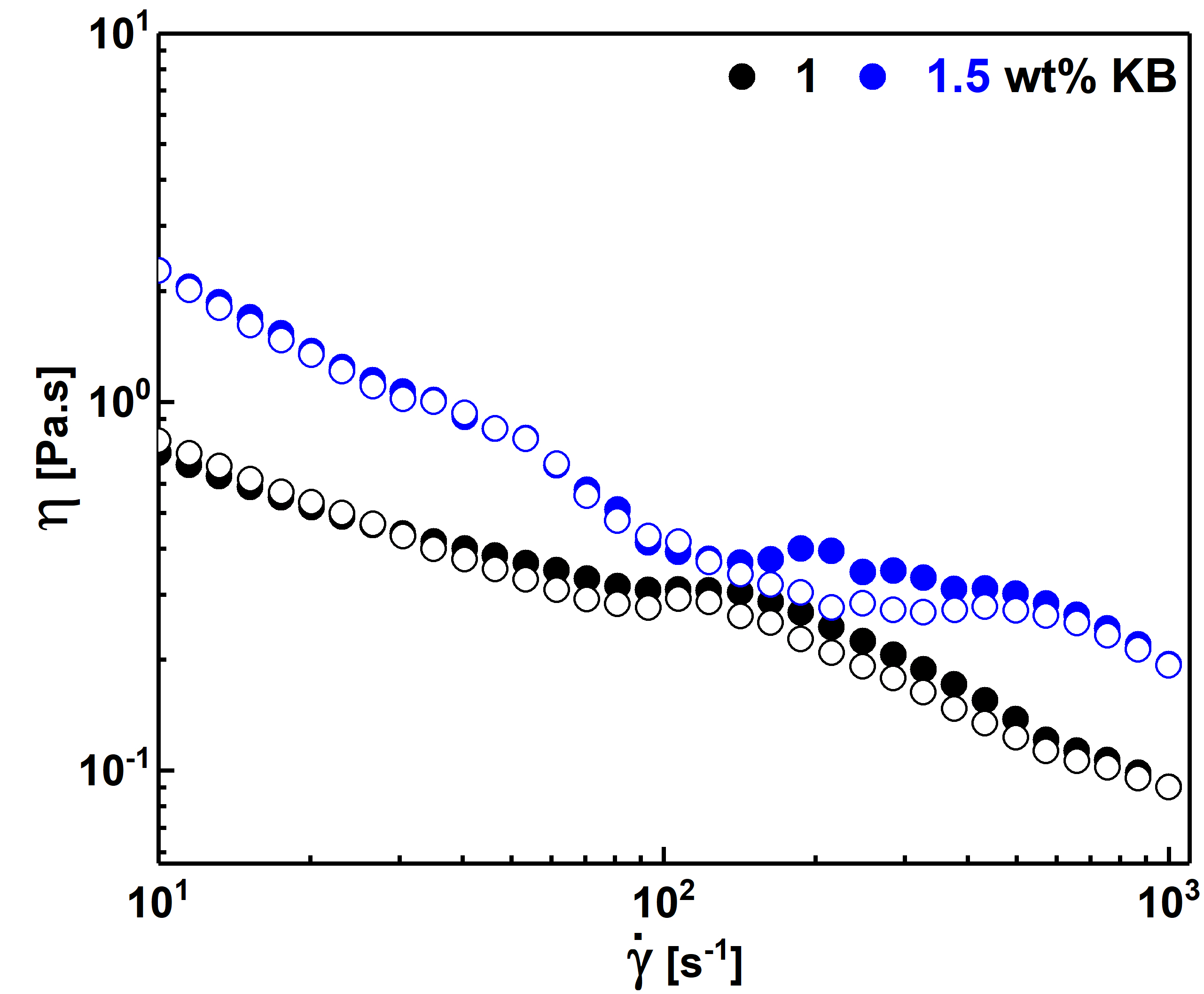
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**Figure S4.** The equivalent circuit used to model the Nyquist plots of KB dispersions.

The resultant electronic resistor values (R1) have been used to calculate the electrical conductivity (Σ) of dispersions, considering the geometrical parameter (plate diameter = 25 mm, gap = 1 mm), using this equation:

(S1)

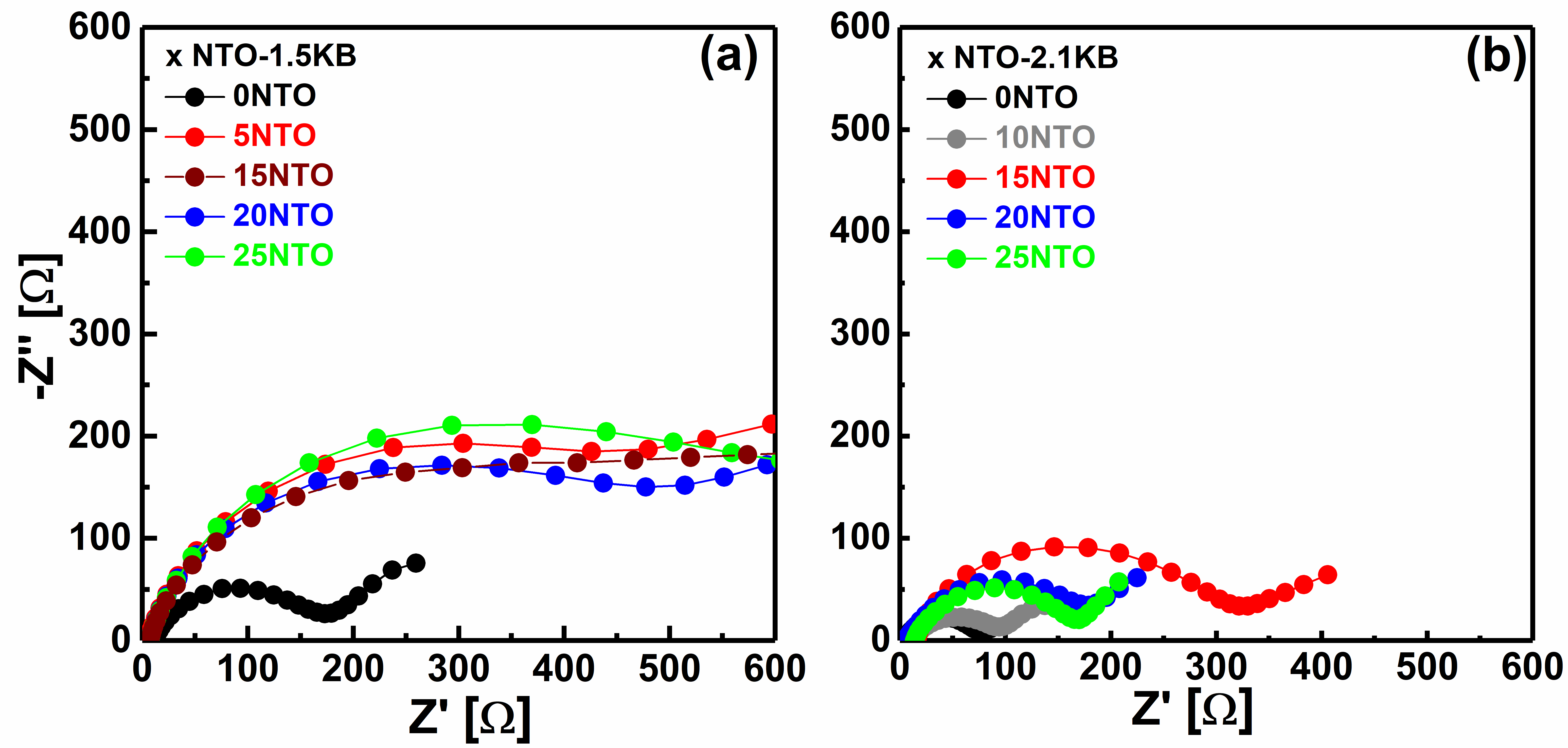
where *l* is the thickness of the sample which is considered as the gap size between parallel plates (*l* = 1 mm), and *A* is the cross–sectional area (*A* = π*r*2) with *r* = 25 mm.



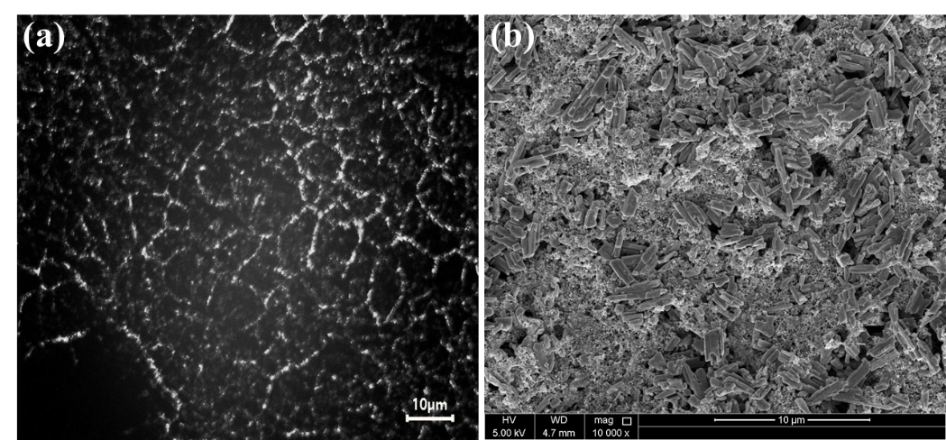
**Figure S5** Variation of shear viscosity (η) with shear rate () for semidilute KB dispersions, at 25 °C. The upscan and downscan of shear rate are represented, respectively, by closed and open circles.

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**Figure S6** Frequency sweep rheograms of NTO–KB anolytes at (a) 1.5 and (b) 2.1 wt% KB at 25 ℃. The dynamic measurements have been done at γ = 0.1%. *x* denotes the content of NTO in wt%. The dashed lines are guide for eyes.



**Figure S7** Nyquist plots of NTO–KB anolytes at (a) 1.5 and (b) 2.1 wt% KB at 25 ℃ and 100 mV. *x* denotes the content of NTO in wt%.



**Figure S5** The morphology of selected anolyte (10NTO-1.5KB) (a) optical micrograph (scale bar = 10 μm), (b) SEM micrograph (scale bar = 10 μm).

**References**

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