

Supporting Information

Nickel Hydroxide Nanofluid Cathodes with High Solid Loadings and Low Viscosity for Aqueous Flow Batteries

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Conversion of weight into volume fraction

The weight fraction, w can be converted into volume fraction (ϕ) as follows:

Weight fraction, $w = m_p / (m_p + m_f)$, expressed as percent

$$\text{or } 1/w = (1 + m_f/m_p)$$

$$\text{or } m_f/m_p = (1-w)/w \quad (S1)$$

$$\text{and Volume fraction, } \phi = V_p / (V_p + V_f), \text{ expressed as percent} \quad (S2)$$

where, subscripts 'p' and 'f' denote nanoparticle and base fluid respectively. Using density ($d = m/v$), we can write equation S2 as

$$\phi = (m_p/d_p) / (m_p/d_p + m_f/d_f)$$

$$\text{or } 1/\phi = 1 + (m_r \cdot d_p)/(d_r \cdot m_p) \quad (\text{S3})$$

Substituting equation S1 in S3, we get

$$1/\phi = 1 + [(1-w)/w] \cdot [d_p/d_r] \quad (\text{S4})$$

At 298K, assuming a density of 4.1 g/cm³ for nickel hydroxide, and water as the base fluid with a density of 0.997 g/cm³, we get

$$\phi = w / (4.112 - 3.112w) \quad (\text{S5})$$

$$\text{or } w = 4.112 \phi / (1 + 3.112 \phi) \quad (\text{S6})$$

which is graphically shown in figure S1.

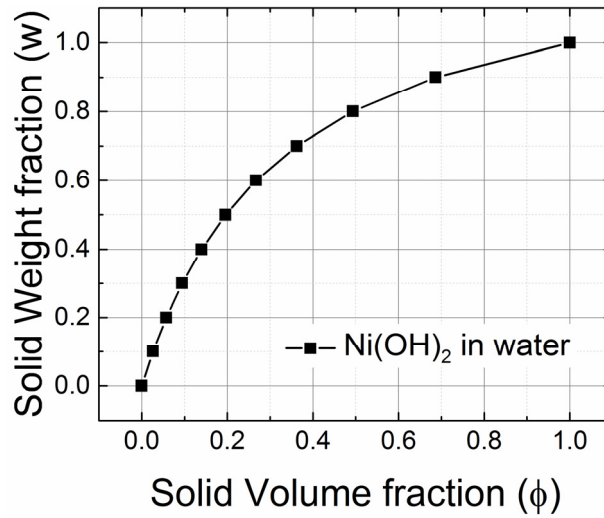


Figure S1. Graphical depiction of the relationship between weight and volume fraction for Nickel (II) hydroxide nanofluids in water.

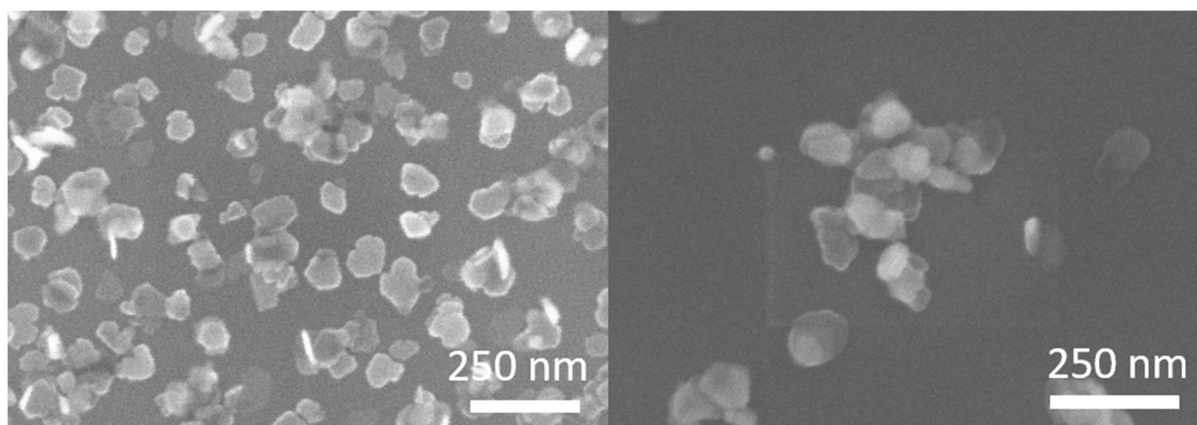


Figure S2. SEM images of (a) pristine Nickel (II) hydroxide nanoparticles ($\text{Ni}(\text{OH})_2$) and (b) sulfonated nickel hydroxide nanoparticles ($\text{Ni}(\text{OH})_2\text{-S}$)

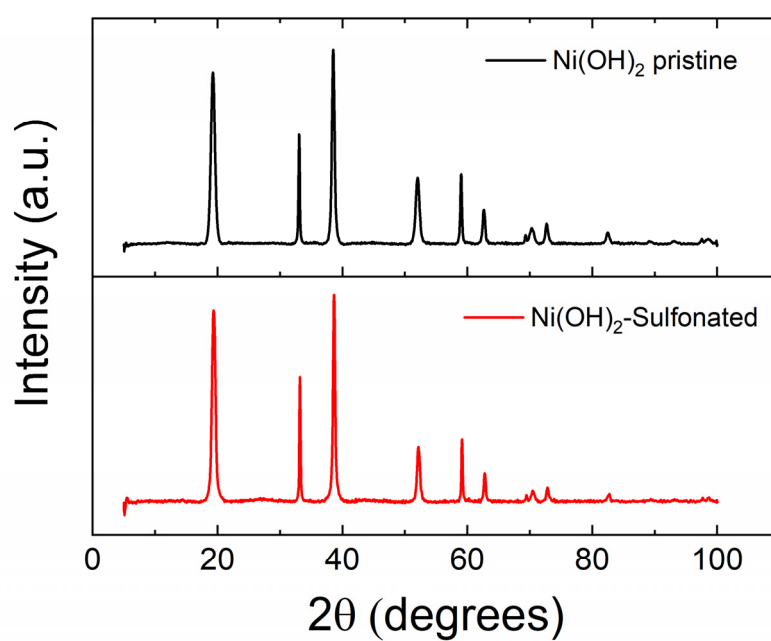


Figure S3. XRD patterns of pristine Nickel (II) hydroxide nanoparticles ($\text{Ni}(\text{OH})_2$) and sulfonated nickel hydroxide nanoparticles ($\text{Ni}(\text{OH})_2\text{-S}$) using a Cu K-alpha source, 0.15406 nm

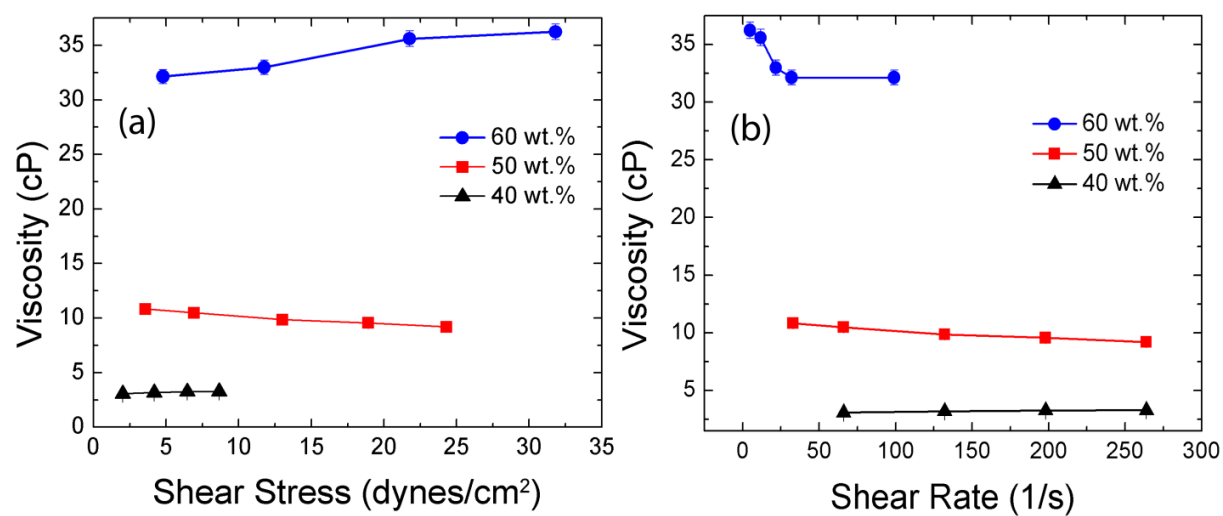


Figure S4. Variation in viscosity as a function of (a) shear stress and (b) shear rate for sulfonated nickel hydroxide nanofluids (Ni(OH)₂-S) at room temperature (with torque >10% and <90%)