Electronic Supplementary Material (ESI) for Industrial Chemistry & Materials.

Supplementary Material

Influence of surfactants on selective mechanical separation of fine high temperature electrolyzer active materials contributing to circular economy

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Physical properties of the studied materials

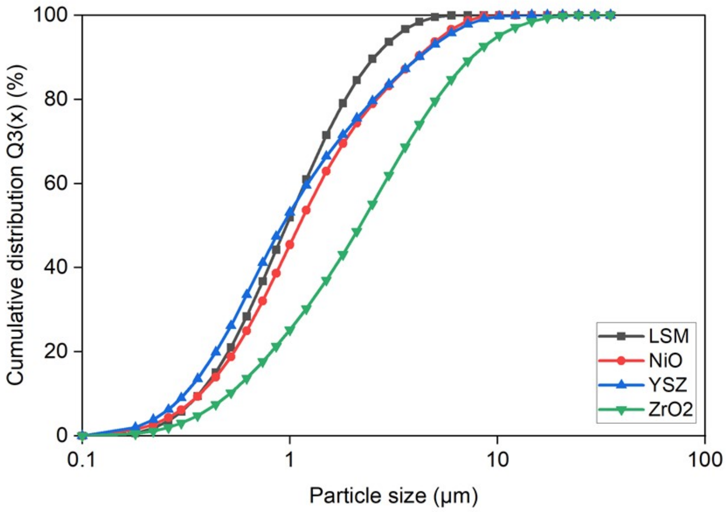


Fig. S1 Cumulative volume (mass) weighted particle size distributions obtained by laser diffraction with dry high intensity dispersing

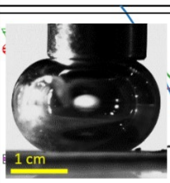
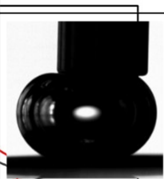
Material	NiO	LSM	ZrO_2	YSZ
Applications	Air side/Anode	Cathode	Electrolyte	Electrolyte
Captive bubble				

Fig. S2 Images of water contact angle of the studied particles using captive bubble method

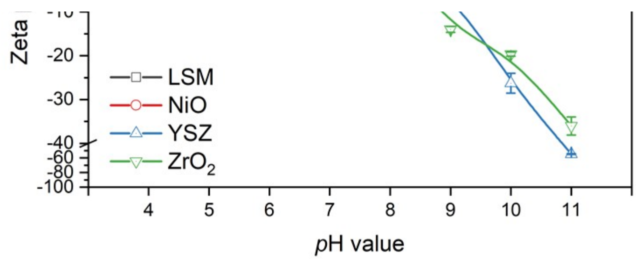


Fig. S3 Effect of pH on the zeta potentials of the HTEL materials. Surface charge of the electrode materials (LSM and NiO) remains positive with increase in the pH. The lines are guides for the eye. The error bars indicate 95% confidence intervals.

Calculation of surfactant molar concentration for covering particle surface (c_s)

Table S1 Information about necessary parameters in the calculation of surfactant concentration for covering each particle surface

	NiO	LSM	YSZ	ZrO_2
Type of surfactant	CTAB		SDS	
Surface area of head group [a,b]	1E-18 m^2		6E-19 m^2	
c_s	1.3E-4 M	8.8E-6 M	2.2E-5 M	6.7E-5 M
Obtained value through measuring zeta potential	1E-5 M	1E-4 M	2E-5 M	5E-5 M

a (Almgren & Swarup, 1983)

b (Das, Roy, Mitra, Dasgupta, & Das, 2005)

c_s =

$$\frac{Mass\ of\ particle\ (g)\ *\ Specific\ surface\ area\ (m^2 g^{-}}{Volume\ of\ solution\ (l)*\ Area\ of\ head\ group\ (m^2)*\ avogadro's\ n}$$

Trial combinations of the surfactant with the dispersion in order to have effective/proper separation

Fig. S4 Effect of different types of dispersants in NiO dispersions at pH 11 From left to right: no dispersant (reference), sodium oleate (NaOl), citric acid (CA), and sodium hexametaphosphate (SHMP)

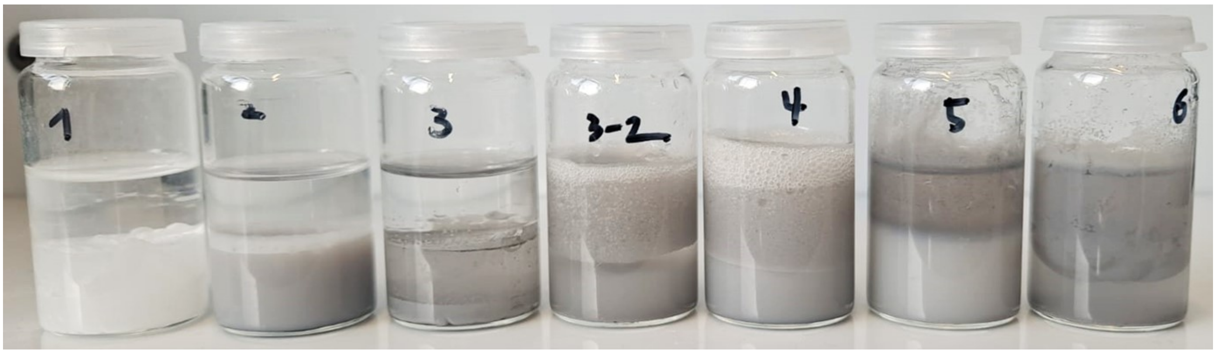


Fig. S5 Effect of different combinations of surfactant and dispersant at different pH. From left to right 1 to 6
1: solid electrolyte materials (YSZ and ZrO_2)with CTAB at pH 11, 2: particle mixtures (NiO, YSZ, and ZrO_2) with SHMP at pH 11, 3: particle mixtures (NiO, YSZ, and ZrO_2) with a combination of CTAB and Citric acid at pH 11, 3-2: same condition as bottle 3 but with higher CTAB concentration at pH 11, 4: particle mixtures (NiO, YSZ, and ZrO_2) with a combination of SDS and SHMP at pH 11, 5:particle mixtures (NiO, YSZ, and ZrO_2)with SDS at pH 8. 6: particle mixtures (NiO, YSZ, and ZrO_2) with SDS at pH 4

Fig. S6 *Particle mixtures (NiO, YSZ, and ZrO_2) with different combinations of surfactant, dispersant, ultrasonic treatment 1: without any reagents at pH 11, 2: with CATB and citric acid at pH 11, 3: with a combination of SDS and SHMP at pH 8, agitation with ultra-sonotrode, 4: same condition as bottle 3 at pH 11, agitation with ultra-sonotrode*

Almgren, M., & Swarup, S. (1983). Size of sodium dodecyl sulfate micelles in the presence of additives. 3. Multivalent and hydrophobic counterions, cationic and nonionic surfactants. *The Journal of Physical Chemistry, 87*(5), 876-881. doi:10.1021/j100228a036

Das, D., Roy, S., Mitra, R. N., Dasgupta, A., & Das, P. K. (2005). Head-Group Size or Hydrophilicity of Surfactants: The Major Regulator of Lipase Activity in Cationic Water-in-Oil Microemulsions. *Chemistry – A European Journal, 11*(17), 4881-4889. doi:https://doi.org/10.1002/chem.200500244