Effect of reaction conditions on size and morphology of ultrasonically prepared Ni(OH)$_2$ powders

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Overview

Ni(OH)$_2$

- Active material in alkaline rechargeable batteries and precursor of NiO (catalysis and ceramic industry) $^1$.
- Performance of these devices depends highly on size and morphology of the nickel hydroxide $^2$.
- Typically synthesized using high-temperature processes and long reaction times $^3$.

Objective

Evaluate the influence on size and morphology of:

- Gas flow rate
- Temperature
- Surfactants
during the synthesis of Ni(OH)$_2$ through aqueous ammonia complexes assisted by ultrasound.

Experimental

All experiments result in $\beta$-Ni(OH)$_2$ (theophyllate).

Influence of Gas Flow Rate

- Open atmosphere: Glass beaker; 1.5 h
- Air flow: Sussick cell; 0.4 slpm, 1.5 h, 0.6 slpm, 4.0 h
- Ice bath

Influence of Temperature

- 10 $^\circ$C: Air flow, 0.4 slpm, Sussick cell; 3.0 h
- 15 $^\circ$C: Air flow, 0.4 slpm, Sussick cell; 3.0 h
- 20 $^\circ$C: Air flow, 0.4 slpm, Sussick cell; 3.0 h

Influence of Surfactants

- Polyacrylamide (PAA)
- Polyvinylpyrrolidone (PVP)
- Poly(vinyl alcohol) (PVA)

- Surfactants were dropped to the liquid media while sonicating.
- Dropping rate 0.11 ml/min.
- Open atmosphere; Regular glassware; 1.5 h, 20 $^\circ$C.

Conclusions

- Effects of environmental variables in the synthesis of Ni(OH)$_2$ by precipitation through aqueous ammonia complexes assisted by ultrasound have been studied.
- It has been observed that controlling the external atmosphere (by using an air flow rate), smaller particle sizes are obtained.
- Temperature affects particle size and morphology. As temperature increases, bigger particles are obtained and morphological changes from platelet-like to spherical aggregates are achieved.
- The addition of surfactants to the reaction media decreases the particle size and force the platelet-like structure.
- The employment of PAA seems to inhibit nickel hydroxide precipitation.

Platelet-like structures with thicknesses lower than 50 nm and diameters lower than 1 μm are obtained using PVP and PVA.

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