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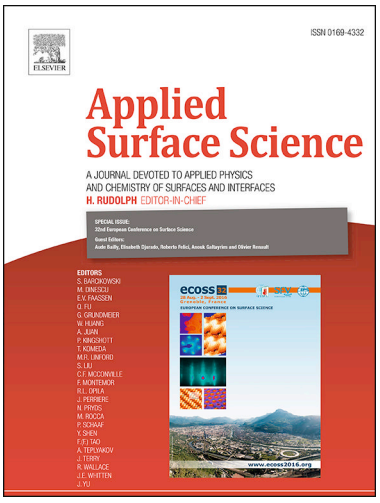

Full Length Article

Effect of water content on the characteristics of hydro-compacted nanosilica

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PII: S0169-4332(18)32108-1
DOI: https://doi.org/10.1016/j.apsusc.2018.07.213
Reference: APSUSC 40028

To appear in: *Applied Surface Science*

Received Date: 21 May 2018
Revised Date: 26 July 2018
Accepted Date: 29 July 2018

Please cite this article as: V.M. Gun'ko, V.V. Turov, E.M. Pakhlov, T.V. Krupska, B. Charmas, Effect of water content on the characteristics of hydro-compacted nanosilica, *Applied Surface Science* (2018), doi: https://doi.org/10.1016/j.apsusc.2018.07.213

Effect of water content on the characteristics of hydro-compacted nanosilica

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Abstract

The morphological and textural characteristics of hydro-compacted nanosilicas (wetted by various water amounts in the range of h_{cp} = 0.3-5.0 g per gram of dry silica, and then dried) were analyzed using low-temperature ^{1}H NMR spectroscopy, SAXS, SEM, TEM, IR spectroscopy, and nitrogen adsorption methods. The results of the hydro-compaction of nanosilica A-300 depend strongly on the h_{cp} value, which can be varied to control reorganization of secondary and ternary structures formed by nanoparticles. The compaction is accompanied by non-monotonic changes in the textural characteristics; however, the nanoparticles *per se* are practically not affected by the treatment. At $h_{cp} \leq 1$ g/g, the reorganization of secondary/ternary structures does not lead to diminution of the specific surface area (S_{BET}); however, at $h_{cp} \geq 1.5$ g/g, the S_{BET} value decreases, but the pore volume increases despite the empty volume of the powder decreases from 21.8 cm^3/g for initial A-300 (bulk density ρ_b = 0.045 g/cm^3) to 3.45 cm^3/g on compaction at h_{cp} = 4.5 g/g (ρ_b = 0.256 g/cm^3). The structural reorganization of hydro-compacted powders is possible after addition of new water amount. This suggests that the chemical bonds between neighboring nanoparticles do not practically form upon the hydro-compaction. Thus, hydro-compacted nanosilica can lose a dust-forming property but remains active with respect to nanoparticles mobility and possibility of reorganization of the secondary structures with nanoparticles.

Keywords: Hydro-compacted nanosilica; Textural characteristics; Secondary structure reorganization; Nanoparticle activity

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Abbreviations: A-300 – initial nanosilica; cA-300 - compacted nanosilica; ESM - electronic supplementary material; IR – infrared; NMR – nuclear magnetic resonance; NPNP - nonporous nanoparticles; PSD - pore size distributions; SCV/SCR – model with slit-shaped and cylindrical pores and voids between NPNP with self-consistent regularization; SAW - strongly associated bound water; SAXS – small angle X-ray scattering; SBW - strongly bound water; SEM – scanning electron microscopy; TEM – transmission electron microscopy; UW – unfrozen water; WAW - weakly associated water; WBW - weakly bound water