

Highly porous alumina monoliths via a novel sol-gel approach

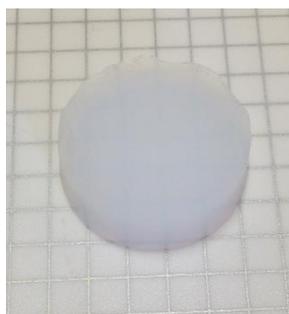
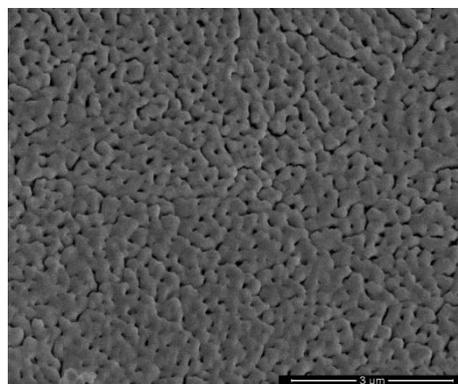
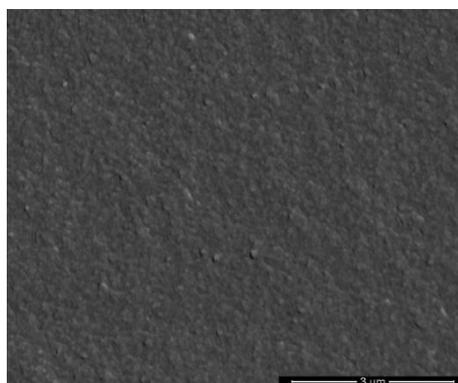
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Aluminum oxide is being widely used in catalyst preparation, mostly as support or washcoat material. Its many advantageous properties include a good moldability, controllable porosity, abundance, and refractoriness (in the α -modification).

A well-established synthetic approach, allowing for very good control over the resulting geometric shape and porosity, is found in the epoxide-mediated sol-gel synthesis starting from aluminum salts. [1, 2]

In our novel approach, the cancerogenic epoxide is rendered obsolete by mutual cross-hydrolysis of an aluminum alkoxide and an aluminum salt. This route has been utilized before to synthesize bimetallic oxides, e.g. yttria-alumina. [3]

Upon dissolution, the aluminum salt dissociates into solvated anions and $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ -complexes. In a concerted, simultaneous cross-hydrolysis, the Al-hexaaqua-complexes are then hydrolyzed by the much more reactive alkoxide, while at the same time the alkoxide is also hydrolyzed in the strongly acidic medium by nucleophilic substitutions of protonated OR-groups by water. It hence disproportionates into $[\text{Al}(\text{OH})_n(\text{H}_2\text{O})_{6-n}]^{(3-n)}$ -complexes and solvent molecules. The Al-complexes undergo hydrolytic oxolation, yielding an interconnected alumina network structure, as shown by the SEM images on the right. [4]



When performed in an autoclave at 80 °C, this novel synthetic approach yields mechanically stable cylindrical alumina monoliths ($\varnothing = 20$ mm, $h = 10$ mm). Moreover, porosity values are significantly increased with respect to the plain xerogel, after calcination at 600 °C. Thus, the cumulative pore volume reaches values of up to 3.6 cm^3/g , with a specific surface area of approximately 500 m^2/g , as determined by mercury intrusion. [4]

References

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