Porous lyocell powders as sound absorbers

Supporting Information

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1. MATERIALS AND METHODS

Cellulose II gel (also referred to as LENZING™[a] Lyocell or lyocell gel was supplied by Lenzing AG (Lenzing, Austria). It has a solid content of 4% and was stored at 8°C. *tert*-BuOH (p.a.) was obtained from Carl Roth.

Preparation of cellulose II powders

The cellulose II gel (4 wt%, 93.8 g) was diluted by addition of *tert*-BuOH (previously molten at 50°C) to a volume of approx. 750 mL, which corresponds to a solid content of 0.5 wt%. The suspension was shaken overnight at room temperature, transferred into a 1.2 L metal mold and frozen at -80°C. The frozen sample was freeze-dried in a lyophilizer (Christ, Osterode, Germany, Beta 1-8 LDplus, T = -56°C, p = 0.2 mbar). After freeze-drying, the powder was stored in a closed vessel.

Nitrogen sorption experiments

Nitrogen adsorption and desorption isotherms were recorded on a TriStar II PLUS from Micromeritics at 77 K after degassing the cellulose powders under vacuum at 40 °C for 24 hours (VacPrep 061, Micromeritics). The bulk density of the powder sample was measured before and after vacuum drying. The specific surface area was determined from 16 data points corresponding to the linear range (P/P0 = 0.05-0.3)[1] of the adsorption branch using the Brunauer–Emmett–Teller (BET) method.[2] Mesoporosity of the samples was evaluated by the BJH (Barrett–Joyner–Halenda) method[3] based on the modified Kelvin equation, using the Broekhoff-De Boer model.[4]

Laser granulometry

[a]LENZING™ is a trademark of Lenzing AG.

All samples were measured on a Malvern Mastersizer 3000 working with a dual light source (470 nm and 632.8 nm). Samples were measured in the dry state in an air flow with an Aero S dry powder dispersion unit. The optimized working pressure was set to 2 bars, and the feeding rate was set constant at 70 %. Optical properties for data analysis were set to 1.47 and 0.01 for refractive index and absorption coefficient, respectively.[5]

Scanning electron microscopy (SEM)

The samples were sputtered (Leica EM SCD005 sputter coater) with a gold layer of 8 nm thickness and analyzed on a FEI INSPECT S50 instrument (Hillsboro, Oregon, USA). Micrographs were obtained in high vacuum mode at 2 kV.

Acoustic measurement with impedance tube

Acoustic measurements have been performed using an impedance tube and several test specimens with a material thickness of 65 mm. The so-called “two-microphone method” was performed according to ISO 10534-2.[6,7] This measurement procedure allows the determination of the absorption coefficient for a sound incident perpendicularly to the surface of the test specimen. The absorption coefficient describes the ratio between the non-recurring and the incident sound intensity or sound energy (W/m^2). The results were compared to typical materials used in room acoustics. The reference materials were evaluated within the same measurement series and setup.

2. SUPPORTING FIGURES AND TABLES

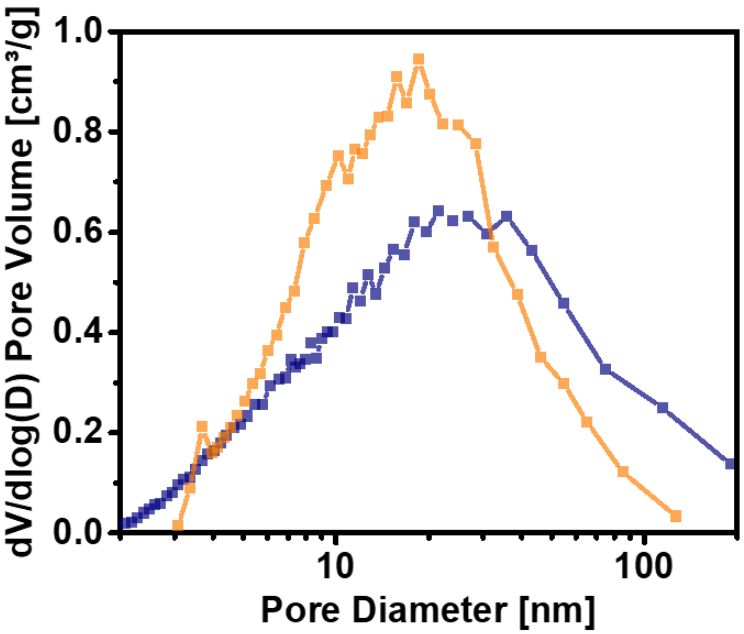

Figure S1: Pore size distributions of the cellulose II powder sample as calculated from the nitrogen adsorption (blue) and desorption (orange) isotherm.

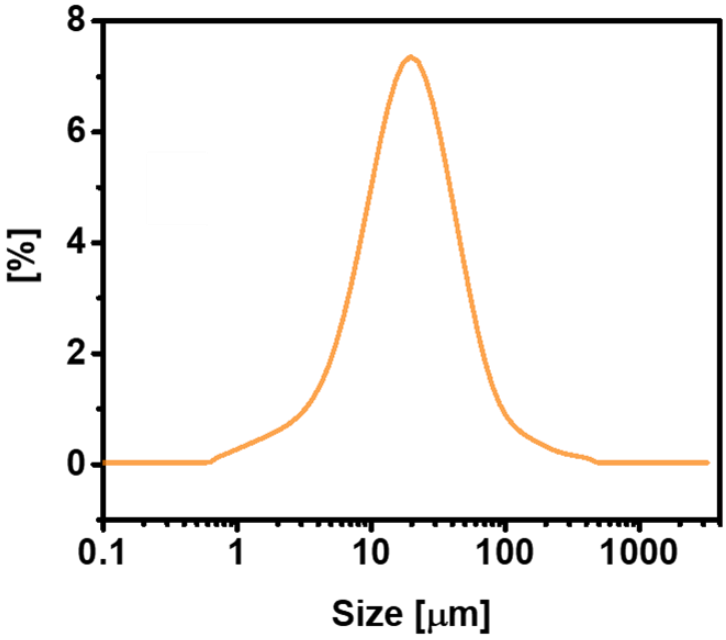

Figure S2: Volume-based particle size distribution for the cellulose II powder as obtained by laser granulometry.

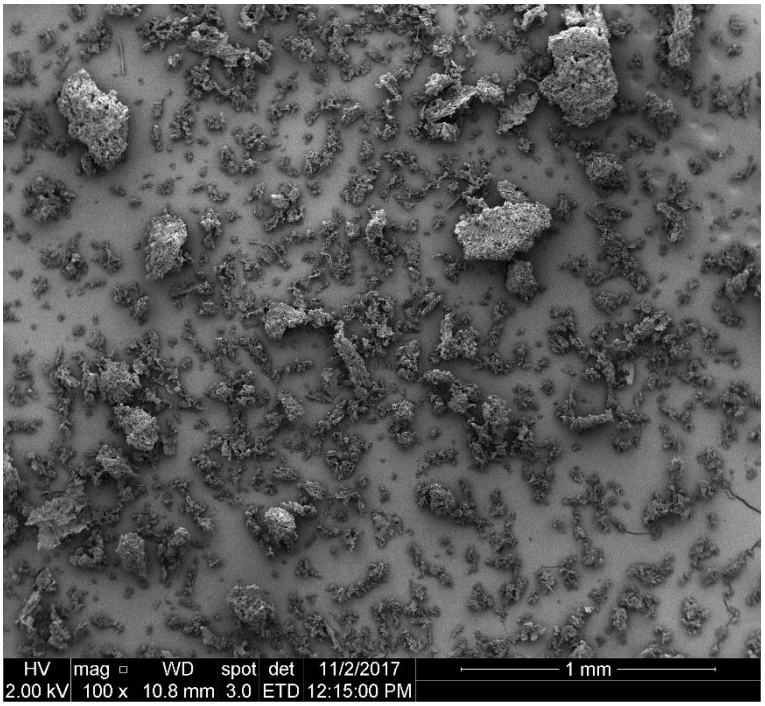

Figure S3: Scanning electron micrograph of the cellulose II powder at a magnification of 100.

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