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Porous Vycor Glass: Interrelation between Morphology, Structure and Water Uptake

In the course of improving the living quality, the regulation of the room-climate becomes more important. A very comfortable way, gentle on resources and effortless, is the use of moisture controlling materials like lumber soft fiber plates, zeolithes, loam and porous glasses. Porous glasses of the Vycor type show some unique properties like low production cost, no inflammability and the adjustable porosity, pore-structure and –shape, which qualify them for a very attractive alternative to other inorganic and organic materials.

The porous glass can be produced as powders with spherical particle diameter below 1 mm, but also as non-spherical particles like flakes. They can be inserted as an additive in wall paintings, fineries and gypsums and can reduce the fluctuation in air moisture content by reversibly storing a large quantity of water in its micro pores. Besides this moisture regulation effect, the vycor glasses can also regulate the room temperature due to the heat losses, which cause a lower heating energy in winter and lower cooling energy in summer.

Vycor-glass is a special kind of alkali-borosilicate glass, containing 5 - 10 wt% Na_2O , 20 - 35 wt% B_2O_3 and 55 - 75 wt% SiO_2 . A heat treatment above 500 °C causes a spinodal demixing into a SiO_2 -rich phase and a NaBO_3 -rich phase. The latter phase is soluble in a wide range of acids or bases.

The pore size obtained in Vycor glass can be modified by varying the demixing temperature: At low temperatures (< 500 °C), pore diameters down to 50 nm can be obtained, while at higher temperatures (700 °C) pore diameters above 100 nm were observed with BET and SEM. Furthermore, the pore content and the structure can be tuned by varying the stoichiometry of the original glass, and the pore surface can be modified by the leaching process. These effects were investigated in detail and several production methods for Vycor glass powders were defined.

To estimate the climate management properties of the Vycor glass, a wide range of thermogravimetric measurement of the water uptake and water release were performed. While the initial composition of the glass did not affect the water absorption rate, the phase separation temperature has a big influence. The maximum water uptake is inversely proportional towards the pore size. Furthermore, cyclization tests show that on changing the water content in the atmosphere, the new equilibrium is reached within one hour. However, the size of the glass particles and their shape (powder or flitter), the temperature and the leaching conditions influence this time, the adsorption and desorption.