Texture characterisation of ultramacroporous materials using x-ray microtomography: application to alumina foams and deer antlers

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The analysis of the porous structure of highly porous materials (pore width >1 µm) and the determination of structure-properties relationships are major issues in several domains including foam and biomedical sciences. Intrusion techniques, such as mercury porosimetry, are commonly used to measure pore volume and pore size distribution of such materials. Nevertheless, this method presents some limitations. Firstly, the mercury porosimetry is limited to maximum pore sizes of 75 µm. Secondly, various authors mentioned the possible alteration of the porous structure, which shrinks under mercury pressure because of low mechanical strength. Finally, the porous structure can be so open that mercury does not intrude the sample but flows through the porous structure, hindering any measurement. In the present study, x-ray microtomography coupled with image analysis is presented as a non-destructive alternative method for the characterization of ultramacroporous materials. This method was successfully tested on alumina foams, before and after Pd-Ag/SiO2 xerogel impregnation for catalysis purposes, and deer antlers which are natural biomaterials presenting a foam-like structure.

Microtomography allowed us comparing the total porosity, porous density and pore size distribution before and after impregnation. Results showed that the quality of impregnation depends on the structure of the alumina support.

Up to now, the porous texture of deer antlers has been determined in a destructive way from histological sections. This method is time consuming and must be largely repeated in order to give statistically relevant results. With its large field of view (@ 2 cm), x-ray microtomography allowed scanning entire or half pieces of antlers, provided the cortical bone forming the outer layer was removed. First results clearly showed a porosity profile along the sample diameter. The pore size distribution was showed to be dependent on the sample original site. Further work is currently carried out in order to study the influence of several parameters (sampling site, deer's age, …) on the textural properties of deer antlers.