Physico-chemical nanomaterials science

Multiple structure of collagen diagnostics of evolution with standard contact porosimetry

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Evolution of multiple porous structure of collagen during procedures of pre-tanning, tanning, retanning and modifications with inorganic particles has been investigated by means of standard contact porosimetry (using octane as a working liquid), TEM and SEM microscopy. Since the porosimetry method allows us to obtain pore size distribution in a wide interval (from 0.2 nm up to 300 m), each type of element of the collagen structure, such as helices, macromolecules, microfibrils, fibrils, primary and secondary fibers as well as non-collagen inclusions, were recognized. The technique, which allows us to calculate porosity due to each structure element, has been proposed. The equation, which connects total porosity with porosity caused by each structure element after certain stage of the collagen treatment, has been obtained. This expression is a linear polynomial function, the coefficients of which indicate loosing-compaction of the hierarchical structure. Ordering-disordering of the structure were estimated using integral and differential pore size distributions from a change of the curve build-up or of the peak wideness respectively. Chemical treatment before tanning causes removal of non-collagen inclusions, which form secondary porous structure inside collagen matrix. Removal of the inclusions results in fluffing of collagen structure on the levels of regular fibrils and primary fibers. Tanning and retanning cause compaction on the levels of microfibrils and fibrils as well as ordering of these fibers evidently due to their shrinkage. Compaction of larger fibers occurs after modification of collagen with inorganic particles of micron size (bentonite flakes), thickening of these structure elements results in an increase of tensile strength of the modified sample.