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Moisture Content to mitigate stiffness in modified collagen fibril structures

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Skin derived collagen materials, such as leather, are required to be both flexible and strong to suit their function as garments and other hard wearing covers. The natural operating environment of skin is highly hydrated giving the tissue elasticity and suppleness. However, when the tissue is dehydrated to form products like leather, the material properties change to being stiffer. The mechanical properties of collagen are known to change with dehydration. Changes in water concentration result in structural changes in the collagen affecting its mechanical properties. Material strength depends in part on collagen fibril alignment; however leather produced by tanning under strain not only increases the fibril alignment but also leads to less flexible leather. The structural basis for flexibility in leather was investigated and the moisture content varied. Small angle X-ray scattering was used to determine collagen fibril orientation, D-spacing and intermolecular spacing conditioned at controlled relative humidity environments. Flexibility was measured by three point bend tests. Mechanical observations showed the relative fibril orientation to be a dominate feature in material stiffness but when moisture contents were increased so was the flexibility. Closer inspection of the leather structure as the moisture content increased showed the collagen fibrils to have larger intermolecular spacing, fibril diameters and D-spacing. It is suggested that the collagen fibrils are lubricated by water which gives them greater freedom of movement and therefore greater flexibility. Applying strain during tanning to increase the fibril alignment also increases the packing of the collagen molecules, reducing their ability to move relative to each other. This is mitigated to some extent with increasing moisture content. Our findings offer insights into how the moisture content of leather can be controlled to optimize properties in the final product.

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