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Among various methods for structural studies of biological macromolecules, neutron scattering and diffraction have a unique feature that the contrast between the scattering length density of the molecules and that of the solvent can be varied easily by changing D_2O content in the solvent. This "contrast variation" technique enables it to obtain information on internal fluctuations or a variation of scattering length density of the molecules of interest. Here, in order to explore the possibilities of neutron fiber diffraction, the contrast variation technique was applied to measurements of neutron fiber diffraction of muscles. The neutron fiber diffraction patterns of frog sartorius muscles were measured under the relaxed state where no tension of the muscle is produced, and under the rigor state where the myosin heads of the thick filaments bind tightly to actin in the thin filaments, in various D_2O concentrations. It was shown that under both states, there were reflections having distinct contrast matching points, indicating a variation in the scattering length density distribution in the unit cell of the muscle structure. Analysis of the equatorial reflections showed that the phase information of these reflections is obtained, that the density projected to a plane perpendicular to the axis of the muscle is different between the thick filament region and the thin filament region, and that the projected density of the thick filament changes as the state of the muscle changes from the relaxed state to the rigor state. Analysis of the meridional reflections of the thick filament suggested that in addition to contributions from the myosin head regions, the backbone region of the thick filaments contributes to the intensity of the meridional reflections as well.

Keywords: fibre diffraction, muscle, neutron diffraction

P13.03.04

Acta Cryst. (2008). A**64**, C563

Molecular orientation of a collagen hydrogel with high mechanical strength

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Collagen is a major fibrous protein of the extracellular matrix. The molecule has a triple-helical structure and is known to assemble to form fibrils. Furthermore, collagen fibrils organized into one direction to form fibers in tendons and ligaments. The orientation of these molecules is known to be a significant factor in the mechanical strength of natural tissues such as bone, tendon, ligament and the cornea. Accordingly, the construction of collagen gels with oriented fibrils attracts much attention for tissue engineering. We reported a novel and simple method to prepare collagen gels with molecularly oriented fibrils. In this study, x-ray diffraction measurements were performed to confirm the molecular orientation in the gels. Amazingly, the pattern of oriented gel was quite similar to that of native tendon collagen, which shows narrower arc pattern than that of non-oriented gel (Fig.1). The results of the diffraction patterns clearly suggested a highly-ordered molecular orientation of the fibrils in the oriented gels. We succeeded in the controlling of the orientation of the fibrils in the gel. This technique is considerably effective as the regenerative medicine technology.

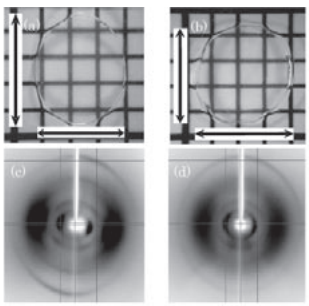

Fig. 1 Optical photomicrographs and X-ray diffraction patterns of oriented (a and c) and non-oriented (b and d) collagen gels, respectively.

Keywords: collagen, fibre diffraction, molecular orientation

P13.03.05

Acta Cryst. (2008). A**64**, C563

Multiple scattering of light by collagen nanofibres in biological tissues

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Some biological tissues look like a fibrillar texture, which can provide an intense response to incident electromagnetic waves. This gives the possibility to perform investigations of optical properties and structure of such natural textures. Natural collagen fibrils are encountered, for example, in the cornea and sclera. Both cornea and sclera tissues are essentially binary nano-composite materials, consisting of collagen fibrils embedded in a water-based mucopolysaccharide background substance, whose refractive index is different from the refractive index of collagen fibres. It is well known (e.g. see [1]) that difference in the structure of cornea and sclera is governed by the arrangement and sizes of collagen fibrils in the background substance, which makes such a difference in the optical performance of the transparent cornea and the opaque sclera. Here we explain optical properties of cornea and sclera by 2D quasi-crystalline lattice model constructed from rods (fibres) of dielectric constant infinite in one direction. Bloch proved in 1928 that waves in periodic media can propagate without scattering, their behaviour governed by a periodic envelope function multiplied by a plane wave [2]. This technique can be applied to electromagnetism by considering Maxwell's equations as an eigenvalues and eigenfuctions problem in analogue with Schrödinger's equation (e.g. see [3, 4]). Such approach to considered model of quasi-periodic fibrillar texture takes into account a multiple scattering of light by collagen fibres.

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Keywords: fibre diffraction theory, electromagnetic wave theory, quasicrystal scattering

P13.03.06

Acta Cryst. (2008). A**64**, C563-564

Crystal structures of chitosan and its complexes with hydrogen halides

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