Light scattering study of eye lens proteins in diluted and concentrated solutions

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The cytoplasm of the mammalian eyelens cells consists for about 40% of proteins which on basis of molecular weight and aminoacid composition can be devided in 3 classes: α-, β- and γ-crystallins. (1)
In order to explain the transparency of the eyelens and especially the role of the different crystallins, diluted and concentrated (up to 150 mg/ml) solutions of bovine low molecular weight α-crystallin were studied by classical light scattering and photoncorrelation spectroscopy. The combination of these two techniques gives direct information on the light scattering and transparency of the solutions and on the structure-inducing interactions which influence the light scattering behaviour.
In order to start from a firm basis, the low molecular weight α-crystallins have been characterized in diluted solutions: from a $D^{\circ}_{20^{\circ},w}$ of $(2,27\pm0,04)\times10^{-7}$ cm^2/s, a $s^{\circ}_{20^{\circ},w}$ of $(19,6\pm0,2)$S, a molecular weight of $(810\pm35)\times10^4$ can be calculated.
This result was confirmed by absolute intensity light scattering measurements which resulted in a M_W of $(770\pm35)\times10^4$. Our data also suggest a rather asymmetric structure of low molecular α-crystallin in solution.
At low ionic strength (ω=0,06) both the effective diffusion coëfficient and the scattered intensity show a marked concentration and angular dependence (from 40 mg/ml on) on increasing the concentration.
The diffusion coëfficient fits the relation $D=D^{\circ}(1+\phi c)$ where $\phi=74$ cm^3/g. Above a concentration of 100 mg/ml, a downward curvature is observed although some uncertainties arise on the interpretation of the time dependent correlation function of the scattered light. This deviation is probably due to the fact that interaction modes on various time scales become important, producing a clearly non-exponential correlationfunction.
The scattered intensity at 90°, $I_{90^{\circ}}$, relative to benzene, increases up to a concentration of 50 mg/ml after which a slow decrease in the scattered intensity is observed. This corresponds to a strong decrease in the scattered intensity per concentration unit.
The observed phenomena up to a concentration of 100 mg/ml can be described and related by the introduction of the static structure factor S(K), which results in $D_{eff}\simeq D^{\circ}/S(K)$ and $\langle I\rangle \simeq S(K)\langle I^{\circ}\rangle$. (2)
To elucidate the nature of the interaction, the same measurements have been performed at a higher ionic strength (0,24 M KCl, ω=0,30). The diffusion coëfficient ($\theta\geq90^{\circ}$) showed no longer any concentration dependence although the scattered intensity behaves in the same way as at lower ionic strength.

1. Harding, J.J. and Dilley, K.J. (1976) Experimental Eye Research, 22, 1-73
2. Pusey, P.N. (1975) Journal of Physics A:Math. Gen., 9, 1433-1440.