Physical interpretation of fast flash-induced changes in the near-infrared scattering of isolated bovine rod cell organelles

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Four flash-induced transients in the near-infrared scattering of bovine rod outer segments and isolated discs are physically investigated and compared with each other. Their common characteristic is the saturation at a rhodopsin bleaching of ca. 10%, which was described previously for the so-called 'signal P' (1).

This signal can be observed on randomly oriented rod outer segments as an s-shaped increase of the scattered light with complex millisecond kinetics. Its angular dependence indicates a decrease in the size of the particles, as described previously (2).

A slow signal, termed P_S (first order, τ = 5-25 s at 20°C) is also observed in this system (3). In contrast to the P-signal, this signal has no angular dependence and is therefore interpreted as a change of the refractive index.

On isolated discs, which were re-loaded with the proteins extracted at low ionic strength (4), a third signal is observed (termed P_D, first order, τ = 0,6-1,2 s); its angular dependence indicates a change of the particle refractive index and, in some measurements, a contribution of shape effects.

Using axially oriented rod outer segments, the P-signal splits into a fast axial (10 ms) and a slower radial signal (100 ms). A comparison of their angular dependence with calculated model curves yields, for a bleaching of 1% rhodopsin, an axial shrinkage of $0.5\% \leq \frac{\Delta L}{L} \leq 1.5\%$. The radial signal is also interpreted by a (radial) contraction and estimated as $0.1\% \leq \frac{\Delta R}{R} \leq 0.3\%$. Assuming a fluid plane for the disc membrane, the planar shrinkage induced by one bleached rhodopsin is estimated as 200-600 $Å^2$.

This high value might be related to the binding of rhodopsin to the GTP-binding protein which was shown to be involved in scattering effects, similar in saturation to our observations (5). If and how the different effects described above are related to membrane-bound biochemical processes, is currently investigated.

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