Time-resolved FTIR studies on electron transfer reactions and associated events in photosynthetic reaction centers and membranes

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The bacterial photosynthetic reaction centre (RC) is a model system in bioenergetics, and a helpful tool to better understand the working mechanism of similar enzymes, notably photosystem II.

We investigated the molecular mechanism of electron transfer (ET) reactions and the events (H+ transfer, cofactor displacement, water molecule movement...) associated to them. In parallel to flash-photolysis, the technique used is time-resolved differential FTIR, which can monitor simultaneously – through marker bands – the time evolution of all these events [1,2].

In a first series of measurements, we focused our attention of the effect of hydration, finding that in a RC placed in a compartment with low relative humidity (RH = 11%) the ET reaction are strongly inhibited and the protein response to charge separation is very different from more hydrated samples [3,4].

More in details, dehydration influences deeply:

1) The recombination kinetics of the light-induced charge separation between the primary electron donor (P) and the quinone acceptor (Q_A) [3];

2) the instensity of differential FTIR bands of internal water molecules associated with the Q_A^-/Q_A transition (the band being weaker in the more dehydrated films) [4];

3) the degree of charge delocalization in the primary donor [5];

4) Pronouced changes are observed from NH or OH stretching modes of amino acidic residues (3550–3150 cm^{-1} range) suggesting internal modifications in the RC which stabilize the charge-separated state [4].

In a second series of measurements, we have studied bacterial photosynthetic membranes[6,7]. Following the time evolution of specific bands in the IR, it was possible to visualize the process of reduction of the quinone pool, as well as associated events (e.g. membrane structure modifications). In addition, hints on the mechanism of photo-dissipation of excess energy under strong illumination were found.

The results will be discussed in the framework of the studies on the events associated to ET reaction in photosynthetic proteins.

References

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