Probing cell respiration and Marine photosynthesis by Raman spectroscopy

Constantinos Varotsis

Department of Chemical Engineering,

Cyprus University of Technology, Lemesos, Cyprus

Abstract

Cytochrome oxidase (CcO) is the last enzyme in the respiratory electron transport chain of cells and Nitric oxide reductase (Nor) is the third of the four enzymes of bacterial denitrification responsible for the catalytic formation of laughing gas (N_2O). A common phylogeny of aerobic respiration and bacterial denitrification exists. In the denitrification process, nitric oxide reductase catalyzes the two-electron reduction of NO to N_2O through a heme b_3-non heme Fe_B dinuclear center, whereas in respiration cytochrome *c* oxidase catalyzes the reduction of O_2 to H_2O in a binuclear heme a_3-Cu_B center. Identification of the intermediates and determination of their structures in the reduction of dioxygen to water by cytochrome *c* oxidase (CcO) and NO by Nor are particular important to understanding both O_2 and NO activation by the enzymes. In this talk, the structures of the O_2 and NO intermediate formed in the catalytic sites of the enzymes will be presented.

Marine Diatoms contribute to oxygenic photosynthesis and carbon fixation and handle large changes under variable light intensity on a regular basis. The unique light-harvesting apparatus of diatoms are the Fucoxanthin-Chlorophyll *a/c*-binding proteins (FCPs). I will present resonance Raman spectra of the light-harvesting Fucoxanthin-Chlorophyll *a/c*-binding proteins (FCPs) of the Marine Diatom *Fragilariopsis sp*. The Raman shifts in the ^{15}N and ^{13}C isotope enriched diatom provide the first spectroscopic evidence for the characterization of the C_a-N and C-C marker bands, and thus, of the penta- and hexacoordinated states of chlorophylls *a/c* in the FCPs and the marker C-C bands of Fucoxanthins.

References

1. Discrete Ligand Binding and Electron Transfer Properties of ba_3-Cytochrome c Oxidase from Thermus thermophilus: Evolutionary Adaption to Low Oxygen and High temperature environments, C. Koutsoupakis, T Soulimane, C. Varotsis *Accounts of chemical research* 52 (5), 1380-1390, **(2019).**

2. Probing the Fucoxanthin-Chlorophyll a/c-Binding Proteins (FCPs) of the Marine Diatom Fragilariopsis sp. by Resonance Raman Spectroscopy C. Andreou, C. Tselios, A. Ioannou C. Varotsis *J. Phys. Chem. B*, 127, 9014−9020 **(2023)**.

3. Light harvesting and photoprotective states in the marine diatom Fragilariopsis sp.: functional implications of chlorophylls *c* 1/*c* 2 in the fucoxanthin–chlorophyll *a/c*-binding proteins (FCPs) C. Andreou, C. and C. Varotsis *RSC Advances* **15,** 4322-4330 **(2025).**