Bose Colloquium

S. N. Bose National Centre for Basic Sciences

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18th December, 2024	11.30 AM	At Silver Jubilee Hall	Webinar Link	YouTube Link

Unintended Consequence of Electronic Conduction via Proteins

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Abstract

Multiple research groups find hard-to-understand long-range transport of electrons across several different proteins in various experimental configurations.[a, b] All this holds for quite a range of “common” proteins, to be distinguished from the highly specialized multiheme ones in bacterial nanowires or Ni-dithiophene oligomers in cable bacteria. Because proteins are poly-ionomers, polymers with a high fraction (say, 10s of % of repeating unit) of ionic, i.e., charged groups, an obvious control experiment is to study non-protein poly-ionomeric electronic conduction. The results we obtain from current-voltage-temperature and impedance measurements on poly-ionomers are somewhat unsettling, viz., similar to those with proteins that we study as films with widths well beyond any reasonable tunneling limit. This result contrasts with that of uncharged polymer films of similar width, which behave as expected as an insulator. These results point to the fact that we need to understand junctions with non-biological ionomers as baseline reference before searching for protein-specific mechanisms to explain their electronic conduction. Determining contact resistances is a necessary first, but neglected step. Apart from presenting our experimental data and their controls, I will briefly review possible models (alas mostly without mechanism).

* Parts of the work are collaborations with Marc Tornow & co-workers @ TUMunich and with David Ehre & Ayelet Vilan @ the Weizmann Institute.

[a] S Bera, …. MS, DC, Long-Range, Near-Temperature-Independent and Activationless Electron Transport via Proteins, well beyond Expected Quantum Tunneling Lengths *J. Amer. Chem. Soc*. 145, 24820-24835 (2023)

[b] D Chryssikos…MS, DC, M Tornow, Mono-exponential Current Attenuation with Distance across 16 nm Thick Bacteriorhodopsin Multilayers, *Adv. Funct. Mater*., 2408110 (2024)

Speaker

Professor David Cahen received B.Sc. degree in Chemistry and Physics from the Hebrew University of Jerusalem (HUJ), and Ph.D. in Materials Research and Physical Chemistry at Northwestern University. He pursued postdoctoral studies in biophysics of photosynthesis at HUJ and the Weizmann Institute of Science (WIS). Afterward, he joined WIS, where his research focused on photoelectrochemical and solid-state photovoltaics (PV). Currently, he is a Professor at the WIS. In his research, he aims to understand electronic transport across hybrid molecular/non-molecular, (bio)organic/inorganic materials, including proteins, with emphasis on interface energetics. Additionally, he pursues alternative sustainable energy resources, in particular solar cells. Prof. Cahen received the 2008 Landau Prize for Chemistry and 2012 Israel Chem.Soc. research excellence Prize. He is an AVS and MRS fellow. With D. Ginley, he edited the MRS/Cambridge Un. Press textbook on Fundamentals of Materials for Energy and Environmental Sustainability.