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Cytochrome c oxidase oxygen reduction reaction induced by cytochrome c onto nickel-coordination surfaces based on graphene oxide in suspension

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In vitro investigations on isolated components of the mitochondrial electron transport chain are expected to shed new light on the plethora of bioenergetic functions carried out by mitochondria, affecting the performance of living organisms. This study is focused on assessing the biocompatibility of graphene oxide (GO) derivatives with His-tagged cytochrome c oxidase (CcO), expressed and purified from *Rhodobacter sphaeroides* using the Gibson assembly method. As prepared GO was enriched with carboxylic acid groups yielding carboxylated GO (CGO). CGO was functionalized with nitrilotriacetic acid (NTA) yielding CGO-NiNTA, in the presence of Ni^{2+} ions. We investigated the reaction of horse-heart cytochrome c (Cyt c) with free CcO and CGO-NiNTA-CcO coordination complexes in suspension. Kinetic studies by UV-Visible absorption spectroscopy confirmed that free CcO oxidizes Cyt c and provided a similar indication for immobilized CcO. However, oxygen-consumption measurements using a Clark-type electrode suggested that CGO-based supports are capable of oxygen reduction reaction (ORR), especially in the presence of Ni^{2+} coordination centers. The ORR caused by immobilized CcO could be clearly distinguished from that of CGO-NiNTA in the presence of Cyt c and dithiothreitol (DTT) as a sacrificial reducing agent. The results indicate that while the protein content is about 3% by mass with respect to the support, the contribution to the oxygen consumption activity ranges from 39.3% to 71.0%, depending on the concentration of DTT. This finding indicates that the support stabilizes the free enzyme which, while capable of Cyt c oxidation, is unable to carry out oxygen consumption in solution. The turnover rate was as high as 599 O_2 molecules per CcO unit per second.

Biography

Michele Vittadello has received his PhD in Chemical Sciences in 2003 from the University of Padua in Italy with Dr. Vito Di Noto. He spent two years (2003-2005) as a Post-doctoral Fellow in the lab of Dr. Steve Greenbaum at the City University of New York - Hunter College. He was a Post-doctoral Research Associate in the Materials Science and Engineering Department at Rutgers, The State University of New Jersey (2005-2008). While at Rutgers, he was awarded funding by the Rutgers Energy Institute (2007-2008). He is primarily interested in the investigation of fundamental physical-chemical properties of nanomaterial, biomaterials and materials with potential applications in the fields of energy storage/generation, biotechnology and radio-remediation. In the Fall of 2008, he joined the faculty at CUNY - Medgar Evers College as an Assistant Professor of Chemistry and was promoted to Associate Professor with tenure in the Fall 2015. He has held visiting positions at Rutgers University (Department of Chemistry) and Princeton University (Department of Chemistry). His work appeared in several articles published in international journals such as J Phys Chem, Macromol Chem and Phys, Electrochimica Acta, Journal of the Electrochemical Society, Solid State Ionics, J. Power Sources, Inorganica Chimica Acta, ChemSusChem, and Carbon.

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