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Comparative redox electrochemistry and oxygen electrocatalysis of mononuclear and dinuclear ball-type phthalocyanines

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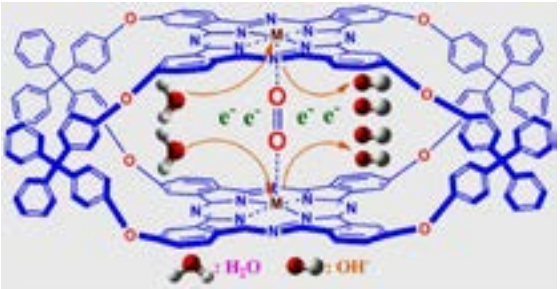
The synthesis of a dinuclear ball-type phthalocyanine (BTPc) containing two cofacial ligands and two metal (M) centers was reported for the first time by Zefirov and coworkers in 2002. However, the first article reporting not only synthesis, but also various physicochemical properties of BTPc compounds was published by our group in 2006. This motivated our group to identify electrochemical, spectroelectrochemical and electrocatalytic properties of the newly synthesized examples of these compounds and thus, the relevant studies have been still continuing. Due to the wide range of intermolecular and intramolecular interactions between the face to face Pc rings and/or the two metal centers, these compounds exhibit different and interesting electrochemical and electrocatalytic properties, as compared to their parent monomers. These interactions appear to depend on the nature of the metal centres, bridging links and the presence or absence of axial ligands and thus, can be tuned by changing and/or modifying these species. The enriched ligand and metal-based reduction and oxidation properties of BTPc compounds as a result of the splitting of the classical redox processes of mononuclear Pc compounds lead to their efficiency in electrocatalytic processes. For instance, in aqueous acidic medium, ball-type cobalt and iron Pc complexes usually display high catalytic performance toward oxygen reduction reaction (ORR) which is important for fuel cell applications. The catalytic activities of some BTPc compounds towards ORR have been tested, also in basic aqueous media, in our recent studies. The results encouraged us to test their catalytic performance also in metal-air cells. These studies continues with a project focusing determination of the effect of bridge length and thus, the distance between the two MPc units in BTPc structure on the performance in oxygen electrocatalysis and zinc-air battery.



Recent Publications

1. Orman EB, Odabas Z, Ozkaya AR (2018) High electrochemical versatility and applicability with metal phthalocyanines carrying peripheral 2,3-dihydro-1H-inden-5-yloxy substituents: rich redox behavior, oxygen electrocatalysis and electrochromism. J. Electrochem. Soc. 165(9): H530-H548.
2. Kocyigit N, Ozen UE, Ozer M, Salih B, Ozkaya AR, Bekaroglu O (2017) Electrocatalytic activity of novel ball-type metallophthalocyanines with trifluoro methyl linkages in oxygen reduction reaction and application as Zn-air battery cathode catalyst. Electrochim. Acta 233:237-248.

3. Koksoy B, Orman EB, Kuruca H, Bulut M, Durmus M, Ozkaya AR (2016) Mono and double-decker lutetium phthalocyanines bearing iodine groups: electrochemical and electrochromic properties. J. Electrochem. Soc. 163(10): H927-H936.
4. Ozen UE, Dogan E, Ozer M, Bekaroglu O, Ozkaya AR (2016) Communication-High-performance and non-precious bifunctional oxygen electrocatalysis with binuclear ball-type phthalocyanine based complexes for zinc-air batteries. J. Electrochem. Soc. 163(9): A2001-A2003.
5. Altun S, Orman EB, Odabas Z, Altındal A, Ozkaya AR (2015) Gas sensing and electrochemical properties of tetra and octa 2H-chromen-2-one substituted iron(II) phthalocyanines. Dalton Trans. 44(9):4341-4354.

Biography

Ali Rıza Özkaya received his undergraduation, master's degree and PhD from Marmara University, in 1980, 1984 and 1990, respectively, and became professor at the same university in 2005. He is the head of Physical Chemistry Department at Marmara University since 2012. His research interest ranges from electrochemical redox, *in-situ* spectroelectrochemical, electrochromic and electrocatalytic properties of organic and inorganic based macrocyclic compounds, especially phthalocyanines, to electrochemical energy convertion and storage. He has published more than 100 papers with total citations higher than 2000 in SCI journals. He has been serving as an editorial board member and electrochemistry topic editor of Turkish Journal of Chemistry.

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