$Ti_3C_2T_x$ MXene Bonded Perylene Diimide as a Robust Charge Host for Seawater Electrolytes

Sreelakshmi P [a], Soujanya H Goudar [b], Soumyaranjan Behera [b], Kotagiri Venkata Rao*[b], Ambika S*[c], and Narendra Kurra*[b]

[a] Center for Interdisciplinary programs, Indian Institute of Technology Hyderabad, Kandi-502284, Sangareddy, Telangana State, India

[b] Department of Chemistry, Indian Institute of Technology Hyderabad, Kandi-502284, Sangareddy, Telangana State, India

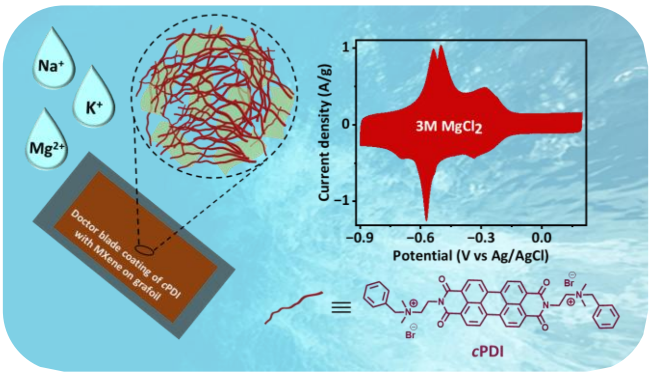
[c] Department of Civil Engineering, Indian Institute of Technology Hyderabad, Kandi-502284, Sangareddy, Telangana State, India

Email: id22resch11011@iith.ac.in, narendra@chy.iith.ac.in

Abstract

Organic materials are an emerging class of redox charge hosts for sustainable metal ion-based electrochemical energy storage systems. The abundance in the constituent elements, like C, H, N, O, P, S and ease of processability make these electrode materials highly affordable and sustainable. However, the dissolving effects in the electrolyte medium, poor electrical conductivity, and mechanical instability make organic materials the least suitable for their application as a sustainable electrode material. The proper fabrication of the electrode material can prevent these drawbacks of organic materials to be suitable for sustainable energy storage applications. Moreover, seawater is an abundant natural resource for designing sustainable and economical large-scale energy storage systems. Here, we reported $Ti_3C_2T_x$ MXene bonded cationic perylene diimide (*c*PDI) as a redox-active charge storage material for seawater-based electrolytes such as NaCl, KCl and $MgCl_2$. By integrating $Ti_3C_2T_x$ MXene, it regulates and promotes the interaction of cations with the carbonyl groups of *c*PDI and also plays the role of conductive and mechanical support for stabilizing the organic electrodes. The *c*PDI electrode provides a reversible and stable charge storage capacity of ~ 101 mAh/g at a current density of 0.25 A/g in 3M $MgCl_2$ electrolyte with an extended cycling stability for over 8000 cycles. The redox charge storage dynamics of *c*PDI in metal-ion electrolytes are mapped through three-dimensional (3D) Bode plots.

Scheme



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