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ONLINE LECTURE

"Densely and selectively functionalized graphenes for energy and the environment"

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Densely and selectively functionalized graphenes for energy and the environment

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Abstract

Functionalization of graphene can mitigate its tendency for restacking and boost interactions with target chemical species. Fucntionalization must be selective and dense if high performance is required, combined with stability in challenging environments. Such properties are pre-requisites for sustainalbe sorbents and electrode materials for energy storage and catalysis.

By leveraging the susceptibility of fluorographene to nucleophiles, advanced and tailored graphene derivatives can be obtained for targeted applications. Graphene acid (GA), cyanographene (G-CN), superdoped graphene are indicative examples. GA bears carboxyls which are strong metal-coordination sites. Therefore, GA exhibits high proclivity for sorption and sensing of Cd^{2+} and Pb^{2+}, as well as for the valorisation of waste Pt for developing electrocatalysts for the oxygen reduction reaction. The all-covalent and spacer-free C-COOH bonds render GA bullet-proof in highly acidic media, enabling metal recovery and full sorbent regeneration.[4] As Li-ion battery anode, GA reveals i) high redox capacity stemming from its carboxyl groups, ii) high conductivity, boosting the rate capability, and iii) extra charge storage due to the co-presence of high content in sp^2 moieties serving as Li intercalation sites. The nitrile groups of G-CN display the required coordination strength and electronic communication with the aromatic skeleton of graphene for preparing undercoordinated and mixed valence catalysts, enabling the effective production of pharmaceutical synthons via cooperative mixed-valence single atom catalysts.

Such graphene derivatives lay the ground for the development of the next generation materials for energy storage, catalysis, sorption and environmental monitoring.