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Covalent functionalization of graphene for chromatographic separation of chiral pharmaceuticals

Graphene continues to be in the focus of scientific and practical interest thanks to its unique properties and promising potential applications. In recent years, chemical modifications of this material have further broadened its appeal and possibilities. Covalent modifications of graphene are particularly interesting in light of the expected high chemical and mechanical stability of the functionalized material. Our research, initially driven by a purely academic interest in the covalent attachment of functional groups to graphene, has recently progressed toward a brand new and exciting avenue of graphene biochemical and pharmaceutical applications. We began with the reaction of benzyne cycloaddition, one of many variants of graphene functionalization, developing a method of benzyne [2+2] or [2+4] cycloaddition modification of epitaxial graphene and bulk graphite [1]. Next, we explored another promising reaction – the modification of graphene with tetracyanoethylene oxide (TCNEO). Recently, Cao and Houk reported on the computational prediction of the pristine attachment of carbonyl ylide to graphene [2]. In our work, among other results, we provided experimental verification of this prediction [3]. TCNEO attachment to graphene introduces reactive cyano groups to the material, opening a wide spectrum of possible secondary modifications and uses. For instance, we have found that mesoporous three-dimensional graphene nanosheets (3D GNS) functionalized with TCNEO and (S)-(+)-2-pyrrolidinemethanol can work as chiral stationary phases (CSPs) for chromatographic separation of chiral pharmaceuticals [4]. Graphene-based CSPs are chemically stable at the pH values ranging from below 1 to 10, and up to an order of magnitude less expensive than standard silica-based analogues.

References

[1] I.V. Magedov, L.V. Frolova, M. Ovezmyradov, D. Bethke, E. A. Shaner, and N. G. Kalugin, Carbon 54 (2013) 192–200
[2] Y. Cao and K.N. Houk, J Mater Chem. 21 (2011) 1503–8
[3] L. V. Frolova, I.V. Magedov, A.Harper, S.K. Jha, M.Ovezmyradov, G.Chandler, J.Garcia, D. Bethke, E.A. Shaner, I.Vasiliev, and N.G. Kalugin, Carbon 81 (2015) 216–222
[4] L. Candelaria, L.V. Frolova, B.M.Kowalski, K.Artyushkova, A.Serov, and N. G. Kalugin, Scientific Reports 8 (2018) 14747