Materials Innovation Seminar
14:00-15:15, August 30th, 2024
Research Building B110

Supramolecular Assembly of Fullerenes: Zero-to-Higher Dimensions for VOC Sensing, Energy Storage and Beyond

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Buckminsterfullerene (C_{60}), ideally zero-dimensional nanoobject, consists purely of carbon atoms located at the vertices of a series of hexagons (20) and pentagons (12) arranged in a cage lattice (diameter ~ 0.8 nm), defined by alternating single and double bonds [1]. Supramolecular assemblies of fullerene C_{60} in the bulk phase or at an interface using p-stacking interactions enable the production of shape-controlled objects at nano/micro/macro length scales, which can possess excellent optoelectronic properties [2]. This talk will discuss recent advances in producing supramolecular self-assembled fullerene crystals from zero to higher dimensions [3]. We have developed a technique for the expansion of fullerene nanomaterials into hierarchic macro- and mesopores architectures with crystallized frameworks, which showed excellent volatile organic compounds (VOC) sensing performance selective to the aromatic solvent vapors because of the extended p-conjugation together with high porosity and large surface area [4]. We show a unique assembly of fullerene into the cubic-shaped crystal with micron-size pockets, which can be intentionally closed and reopened to differentiate sub-micron-size carbon particles from the polymer resin particles of a similar dimension. Similarly, the transformation of fullerene microtubes to microhorns is capable of microscopic recognition, followed by molecular beaker lithography for the chemical etching of fullerene assemblies into hollow to hierarchic superstructures [5]. We will discuss the direct conversion of fullerene crystals into hierarchically porous carbon materials by direct carbonization and their application as high-performance electrode materials in supercapacitor applications [6]. Finally, we will briefly discuss the fabrication of a novel MOFOF composite by integrating coordination and supramolecular chemistry [7].

References

[1] Kroto, H. W.; Heath, J. R.; O'Brien, S. C.; Curl, R. F.; Smalley, R. E. *Nature* **1985**, *318*, 162.
[2] Kausar, A. *Hybrid Adv*. **2024**, *6*, 100233.
[3] Ariga, K.; Shrestha, L.K. *Mater. Adv*. **2021**, *2*, 582.
[4] Bairi, P.; Minami, K.; Nakanishi, W.; Hill, J.P.; Ariga, K.; Shrestha, L.K. *ACS Nano* **2016**, *10*, 6631.
[5] Hsieh, C.-T.; Hsu, S.-H.; Maji, S.; Chahal, M.; Song, J.; Hill, J.P.; Ariga, K.; Shrestha, L.K. *Mater. Horiz*. **2020**, *7*, 787.
[6] Maji, S.; Shrestha, R.G.; Lee, J.; Hill, J.P.; Kim, J.H.; Ariga, K.; Shrestha, L.K. *Bull. Chem. Soc. Jpn.* **2021**, *94*, 1502.
[7] Bhadra, B.N.; Shrestha, L.K.; Ma, R.; Hill, J.P.; Yamauchi, Y.; Ariga, K. *ACS Appl. Mater. Interfaces* **2024** (In press: https://doi.org/10.1021/acsami.4c09747)

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