Journal of Energy Storage 71 (2023) 108006

Contents lists available at ScienceDirect

Journal of Energy Storage

journal homepage: www.elsevier.com/locate/est

Review article

Covalent organic frameworks as promising materials: Review on synthetic strategies, topology and application towards supercapacitors

H. Shanavaz [a], Niranjan Kannanugu [a], Deepak Kasai [a], K. Yogesh Kumar [a,*], M.S. Raghu [b,*], M.K. Prashanth [c], Moonis Ali Khan [d], Byong-Hun Jeon [e,*], E. Linul [f,g,**]

[a] Department of Chemistry, Faculty of Engineering and Technology, Jain University, Bangalore 562112, India
[b] Department of Chemistry, New Horizon College of Engineering, Outer Ring Road, Bangalore 560103, India
[c] Department of Chemistry, BNM Institute of Technology, Banashankari, Bangalore 560070, India
[d] Department of Chemistry, College of Science, King Saud University, Riyadh 1145, Saudi Arabia
[e] Department of Earth Resources and Environmental Engineering, Hanyang University, 222, Wangsimni-ro, Seongdong-gu, Seoul 04763, Republic of Korea
[f] Department of Mechanics and Strength of Materials, Politehnica University Timisoara, 1 Mihai Viteazu Avenue, 300222 Timisoara, Romania
[g] National Institute of Research for Electrochemistry and Condensed Matter, Aurel Paunescu Podeanu Street 144, 300569 Timisoara, Romania

ARTICLE INFO

Keywords:
Covalent organic frameworks
Synthesis
Topology
2D and 3D COFs
Capacitors
Supercapacitor

ABSTRACT

Covalent organic frameworks (COFs), featuring an elastic molecular pattern, highly ordered structures, and persistent porosity, are a new family of covalently connected crystalline organic polymers. Predesigned structure, controlled synthesis, and managed functionalities are the key characteristics of COFs in contrast to other polymers. In principle, extended topological design diagrams volunteer geometrical guidance for the structural tiling of extensive porous polygons, and predesigned primary and high-order structures can be synthesized using polycondensation reactions. The achievement of linking atoms in 2D and 3D to build extensive framework systems pushed the chemistry of COFs from structures to methods, emphasizing the prospective future

Abbreviations: COFs, covalent organic frameworks; 2D, two-dimensional; 3D, three-dimensional; BDBA, (1,4,-benzenediboronic-acid); HHTP, (2,3,6,7,10,11-hexahydroxytriphenylene); THF, tetrahydrofuran; CTFs, covalent triazine frameworks; PTCDA, perylenetetracarboxylic dianhydride; TAPB, 1,3,5-tris(4-aminophenyl)benzene; PMDA, pyromellitic dianhydride; Tp, 1,3,5-triformylphloroglucinol; BD, benzidine; TpPa-1, 1,3,5-triformylphloroglucinol + *p*-phenylenediamine-1; TpPa-2, 1,3,5-triformylphloroglucinol + 2,5-dimethyl-Pphenylenediamine; BTA, benzenetetramine tetrahydrochloride; HCH, hexaketocyclohexane octahydrate; MNPs, magnetic nanoparticles; NPs, nanoparticles; SCOFs-1, surface covalent organic frameworks-1; SCOFs-2, surface covalent organic frameworks-2; HOPG, highly ordered pyrolytic graphite; SLG, single layer graphene; SiOC, silicon oxycarbide; TBPS, tetra (4-dihydroxyborylphenyl)-silane; TBPM, tetra (4-dihydroxyborylphenyl)-methane; (Cu(PDB) 2(BF4)), copper (I)-bisphenanthroline tetrafluoroborate; TFB, poly(4-(sec-butyl)-N-(4-(7-methyl-9,9-dioctyl-9H-fluoren-2-yl)phenyl)-N-(p-tolyl)aniline); BND-Benzophenone, benzophenoneimine of benzidine; TDB, 1,3,5-triindanonebenzene; BFBAPy, 1, 6-bis(4-formylphenyl)-3,8-bis(4-aminophenyl)pyrene; H_2P COFs, phosphanide COFs; ZnP COFs, zinc phosphide COFs; CuP-COF, copper phosphide-COF; $[Cu(PDB)_2(BF_4)]$, [(Cu(*I*)bis[4,4-(1,10 phenanthroline 2,9-diyl) dibenzaldehyde]-tetra Fluoroborate)]; [p-PdPor-CHO], (5,10,15,20-tetrakis-(4-benzaldehyde)porphyrin); (PPDA), para phenylene diammine; (TAPM), (tetra(4-anilyl)methane); DHTPA, 2,5-dihydroxyterephthalaldehyde; NPN-1, 2, 3, nitroso polymer networks-1,2,3; CAF-243, covalent amide frameworks-243; CAF-2, covalent amide frameworks-2; $B(OMe)_3$, trimethyl borate; [BO4]-, tetrakis(spiroborate); TPS, tetraphenylsilane; TPA, 1,3,5,7-tetraphenyladamantine; $[Co(DIP)2]^{2+}$, cobalt-bis (diiminopyridine) complexes; TAPM, tetra (*p*-aminophenyl)methane; TPE-Ph-CHO, 1,1,2,2-tetrakis(4-formyl-(1,1′-biphenyl))ethene; PtS, platinum and sulfur; cRED, rotation electron diffraction; PLQY, photoluminescence quantum yield; PDA, terephthalaldehyde; KMCs, Kinetic Monte Carlo system; $BF_3{\cdot}OEt_2$, boron trifluoride diethyl etherate; WAXS, wide-angle X-ray scattering; DAAQ, (2,6-diaminoanthraquinone); BTA, (benzene-1,3,5-tricarbaldehyde); MPor, metal-based porphyrine; BPDA, 4,4′dicaryladehyde; DMF, dimethylformamide; DBA, benzene-1,4-diboronic acid; COF-LZU, 1,3,5-triformylbenzene+d 1,4-diaminobenzene 2+ 1,4-dioxane+ acetic acid+liq. Nitrogen+ *N*,*N*-dimethylformamide+THF; NMP, N-methylpyrrolidone; ITO, indium tin oxide; BF-CPFs, base-functionalized COFs; $Pd(OAc)_2$, palladium(II) acetate; TFPT, (1,3,5-tris-(4-formyl-phenyl)-triazine); DETH, (2,5-diethoxy-terephthalohydrazide); PI-COF, polyimide COFs; DAAQ-TFP, anthraquinone, 9,10-dihydroxyanthracenes; DTP-ANDI-COF, [(2,3,6,7,10,11-hexahydoxytriphenylene+N, N_9-di-(4-boronophenyl) naphthalene-1,4,5,8-tetracarboxylic acid diimide)]; NDI, naphthalene diimide; DPAI@ CNT, polyarylimide-CNT; EES, electrochemical energy storage; UPS, uninterruptible power supply; hcb, honeycomb; hxl, hexagonal; sql, square lattice; kgd, Kagome-dual; dia, diamond net; ctn, cubic-C_3N_4; bor, borcaite net; pts., platimum sulfide net; ljh, Luojia Hill; srs, $SrSi_2$ net; EDOT, 3,4-ethylene dioxythiophene.

* Corresponding authors.
** Correspondence to: E. Linul, Department of Mechanics and Strength of Materials, Politehnica University Timisoara, 1 Mihai Viteazu Avenue, 300222 Timisoara, Romania.
E-mail addresses: yogeshkk3@gmail.com (K.Y. Kumar), raghuhassan2009@gmail.com (M.S. Raghu), bhjeon@hanyang.ac.kr (B.-H. Jeon), emanoil.linul@upt.ro (E. Linul).

https://doi.org/10.1016/j.est.2023.108006
Received 14 March 2023; Received in revised form 8 June 2023; Accepted 10 June 2023
Available online 23 June 2023
2352-152X/