**Metal Organic Frameworks (MOFs) and Covalent Organic Frameworks (COFs): A benevolent and versatile scaffold for multifunctional utilities in S&T**

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**Abstract:**

Metal-organic frameworks (MOFs), comprised of organic ligands and metal ions/metal clusters via coordinative bonds are highly porous, crystalline materials while Covalent-organic framework(COFs) are a class of porous crystalline material that are connected by strong covalent bonds formed by reacting organic monomers. Their tunable porosity, chemical composition, size and shape, and easy surface functionalization make this large family more and more popular for numerous applications like in oral drug delivery,catalysis,adsorption and sensing of various pollutants especially water,used in electrochemical applications,in photocatalysis or used as biomarkers.Various methods are applied for the synthesis of MOFs and COFs like microwave assisted synthesis,mechanochemical,sonochemical methods,etc.

**Keywords**: Metal organic framework (MOF), Covalent organic framework(COFs),applications, synthetic tactics,scaffolds, organic/inorganic -matrix, benevolent functionality.

**Introduction:**

Metal-organic frameworks (MOFs) and covalent organic frameworks (COFs) represent a relatively new class of materials that have gained significant attention in the scientific community due to their fascinating properties and potential applications. The history of MOFs can be traced back to the early 20th century, but their development as a distinct field of research began in the 1990s.

**Metal Organic Framework (MOFs):**

Metal–organic frameworks (MOFs) or porous coordination polymers, as a type of crystalline porous hybrid materials, are constructed by inorganic building units (metal ions or metal–oxo units) coordinating with electron-donating organic ligands or in simplified way they are coordination polymers consisting of inorganic–organic hybrid frameworks . Their structures are composed of metal centers as connectors and organic ligands as linkers.

However, most MOFs tested to date are derived from non-renewable petrochemical feedstock and transition metals. One of the roadblocks when preparing MOFs from natural products results from the frequent asymmetry of the building units, which do not typically result in significantly high porosities or stability. The high crystallinity and porosity of MOFs along with controllable and tunable pore structures have led to extensive research of MOFs.

Early Development: The concept of coordination polymers, which are the basis for MOFs, can be traced back to the late 19th and early 20th centuries when researchers started studying coordination compounds formed between metal ions and organic ligands. These early studies laid the groundwork for understanding metal-ligand interactions.

Birth of MOFs:

The term "metal-organic framework" was first introduced in a 1999 paper by Omar M. Yaghi and colleagues. The researchers synthesized a porous material, known as MOF-5, using zinc oxide clusters and 1,4-benzenedicarboxylic acid as organic linkers. This groundbreaking work marked the birth of MOFs as a distinct category of porous materials with tunable properties.

Rapid Expansion and Diversity:

Following the discovery of MOF-5, the field of MOFs expanded rapidly. Researchers began to explore various metal ions and organic ligands to create a wide range of MOF structures with different pore sizes, shapes, and functionalities. The diversity of MOFs allowed for applications in various fields, including gas storage, catalysis, drug delivery, and sensing.

Challenges and Advances:

Despite the promise of MOFs, their practical applications faced challenges related to stability, scalability, and cost. Some MOFs showed instability in the presence of moisture or harsh conditions, limiting their real-world applications. Researchers focused on improving the stability and developing post-synthesis modifications to tailor the properties of MOFs for specific applications.

Beyond MOFs:

As research continued, scientists explored new classes of porous materials related to MOFs, such as covalent organic frameworks (COFs) and porous coordination polymers (PCPs). These materials offered additional possibilities for diverse applications

MOFs are characterized by large pore surface area, with micro- and mesopores, and very high designability of pore shape, pore size, and surface functionality and hence utilised in numerous fields like catalysis,adsorption and sensing of effluents especially water or in oral drug delivery,gas storage and separation,etc.Apart from all these applications in recent years, there is an increasing interest in discovering the electrochemical applications in the field of supercapacitors, batteries and fuel cells, hydrogen evolution reaction (HER), oxygen evolution reaction (OER),and oxygen reduction reaction (ORR),electrochemical decomposition of highly oxidizing and toxic compounds, electrochemical sensors, etc.

Metal-organic frameworks (MOFs) are a class of porous materials composed of metal ions (nodes) coordinated to organic ligands (linkers). These materials exhibit a wide range of properties, making them highly versatile and applicable in various fields. Some of the key properties of MOFs include:

High Surface Area: MOFs typically have exceptionally high surface areas, often exceeding thousands of square meters per gram. This high surface area arises from their porous nature, providing ample space for gas adsorption, catalytic reactions, and other interactions with guest molecules.

Tunable Porosity: MOFs offer tunable porosity, meaning their pore sizes and shapes can be customized during the synthesis process. This property allows researchers to design MOFs with specific adsorption properties for different guest molecules, making them valuable for gas storage and separation applications.

Large Voids and Channels: MOFs often have large voids and channels within their structures, allowing for the accommodation of bulky guest molecules. This property is crucial for applications in gas storage, catalysis, and drug delivery, where molecules of varying sizes need to be accommodated.

Gas Adsorption: Due to their high surface area and tunable porosity, MOFs can adsorb and store significant amounts of gases, such as hydrogen, methane, carbon dioxide, and other small molecules. This property is relevant for gas storage, purification, and separation processes.

Selective Adsorption: MOFs can exhibit selective adsorption behavior, where they preferentially adsorb specific gas molecules over others. This property makes them valuable for gas separation and purification applications.

Catalytic Activity: Some MOFs possess inherent catalytic activity due to the presence of metal sites within their structures. These metal sites can facilitate chemical reactions and provide unique catalytic properties, making MOFs attractive for catalysis applications.

Framework Flexibility: Certain MOFs exhibit framework flexibility, meaning their structures can undergo reversible structural changes upon exposure to external stimuli, such as temperature, pressure, or guest molecules. This property is relevant for applications in gas storage, molecular sieving, and stimuli-responsive behavior.

Thermal Stability: Many MOFs exhibit good thermal stability, allowing them to withstand high temperatures without significant degradation. This property is essential for applications in catalysis and gas storage, where stability under operating conditions is crucial.

Photoluminescence: Some MOFs display luminescent properties, emitting light when excited by ultraviolet or visible light. These luminescent MOFs have potential applications in optoelectronic devices, sensors, and imaging agents.

Water Stability: While some MOFs are sensitive to moisture and may degrade upon exposure to water, efforts are being made to develop water-stable MOFs, making them suitable for applications in humid environments and aqueous processes.

Versatility and Functionalization: MOFs can be easily functionalized by introducing different organic ligands or modifying their structures, leading to a wide range of tailored properties and applications.

**Synthetic approach of MOF’s:**

There are various methods for the synthesis of MOFs. The most common and facile route is the solvothermal method, where a mixture of metal salt is heated, and organic linkers are dissolved in a solvent, above the boiling point of the solvent itself. Other methods include microwave-assisted, electrochemical, mechanochemical, and sonochemical synthesis; these approaches differ in how energy is introduced in the synthetic system and result in different reaction time, yields, particle size, and morphology.

The synthesis of metal-organic frameworks (MOFs) has attracted immense attention during the last 2 decades due to the possibility to obtain a large variety of aesthetically interesting structures that could also be of great interest for applications in a number of fields related to porous materials which are based on the pore size and shape as well as the hostguest interactions involved. In addition MOF are also involved in biomedical applications.

Regarding the synthesis of MOFs, often the term “design” has been used. There have been controversial discussions about this term and an interesting personal view has been given recently.The more stringent definition of “design”, which implies “to create, fashion, execute, or construct according to plan” (Webster’s Dictionary), generally is not applicable in MOF synthesis. Nevertheless, the definition and its implications have helped to promote the field.

The term conventional synthesis is usually applied to reactions carried out by conventional electric heating without any parallelization of reactions. The reaction temperature is one of the main parameters in the synthesis of MOFs, and two temperature ranges, solvothermal and nonsolvothermal, are normally distinguished, which dictate the kind of reaction setups that have to be used.

**ALTERNATIVE SYNTHESIS ROUTES**

Energy can also be introduced through other means, for example by an electric potential, electromagnetic radiation, mechanical waves (ultrasound), or mechanically.Alternative synthesis routes are described where energy is introduced through microwave irradiation (microwave-assisted synthesis), application of an electric potential (electrochemistry), mechanically (mechanochemistry,) or through ultrasound (sonochemistry).

**Microwave-Assisted Synthesis:**

Introduction of energy using microwave irradiation is a well established method in synthetic chemistry but has been mainly used in organic chemistry.Nevertheless, solidsolid reactions as well as solution-based synthesis. Microwave-assisted synthesis relies on the interaction of electromagnetic waves with mobile electric charges. These can be polar solvent molecules/ions in a solution or electrons/ions ina solid. In the solid, an electric current is formed and heating is due to electric resistance of the solid. Due to the direct interaction of the radiation with the solution/reactants, MW-assisted heating presents a very energy efficient method of heating. Thus, high heating rates and homogeneous heating throughout the sample is possible.Microwave ovens suited for materials syntheses allow one to monitor temperature and pressure during the reaction and thus allow a more precise control of reaction conditions.MW-assisted synthesis of MOFs has often been carried out at a temperature above 100oC with reaction times rarely exceeding 1 h. Only a few reports describe the systematic variation of compositional and process parameters (solvent, irradiation time, reaction temperature, power level, molar ratio of the reactants, reactant concentration, etc.) in order to optimize the reaction conditions. In general, MW irradiation allows faster synthesis ofsmaller crystals compared to CE heating.

**Mechanochemical Synthesis:**

Mechanical force can induce many physical phenomena (mechanophysics) as well as chemical reactions. In mechanochemical synthesis, the mechanical breakage of intramolecular bonds followed by a chemical transformation takes place.The interest in mechanically activated MOFsynthesis is due tomultiple reasons. One important point is environmental issues. Reactions can be carried out at room temperature under solvent free conditions, which is especially advantageous when organic solvents can be avoided. Short reaction times, normally in the range of 10-60 min, can lead to quantitative yields, and generally products containing small particles are obtained. Moreover, in some cases metal salts can be replaced by metal oxides as a starting material, which results in the formation of water as the only side product.

**Sonochemical Synthesis:**

Sonochemistry deals with the chemistry that takes place upon application of high-energy ultrasound to a reaction mixture.The primary goal of sonochemical synthesis in MOF science was to find a fast, energy-efficient, environmentally friendly, room temperature method that can easily be carried out. This is of specialinterest for their future application, since fast reactions could allow the scaleup of MOFs.

**APPLICATIONS OF MOF’s:**

**1] MOF’S AS ADSORBENTS:**

MOFs are good materials for a future application in the field of EC removal from wastewater through adsorption due to the high porosity and the specific adsorbate/adsorbent interactions.

**Adsorptive removal of toxic heavy metal ions:** The common heavy metal ions in wastewater include arsenic, copper, chromium, lead, mercury, nickel and zinc ions . These ions are toxic or carcinogenic, posing a big threat to humans and other living species. The conventional way to remove these heavy metal ions is to use commercial adsorbents (e.g. zeolites and porous carbon materials) or some bioadsorbents, such as modified coconut waste and modified sawdust. Recently, more attention is being paid to the adsorptive removal by MOFs.

**2] METAL ORGANIC FRAMEWORKS AS PHOTOCATALYSTS:** Photodegradation is theoretically a better method than adsorption for wastewater treatment, mainly because it causes a complete elimination of the pollutant instead of its simple phase transfer, so no further treatment is required. The presence of organic linkers in MOFs allows them to have a relatively wide absorption spectrum permitting the generation of a charge-separated state, which decays in the microseconds, thus permitting photocatalytic applications .

**MOFs for the photocatalytic removal of organic pollutants**

Compared to adsorptive removal, the photocatalytic degradation of organic pollutants is a more thorough way for water purification. For example, the in situ generation of highly reactive transient species (i.e., H2O2, OH, O2) can convert toxic organic contaminants into non-poisonous or less toxic substances . In this regard, recent reports suggest MOFs are new promising candidates as photocatalysts for the degradation of organic pollutants in wastewater.

**Photocatalytic removal of dyes.** Owing to their distinguishing electronic configurations, the central metals of MOFs are suspected to have a great influence on the photocatalytic properties.

**3] MOF AS FLUORESCENCE SENSORS :**

The particular structure of MOFs materials is responsible for the concept of fluorescence performance design of MOFs . Based on the porosity of MOFs, there is liable to build the system of guest@MOFs . The size of the guest and the aperture of MOFs is some of the factors that should consider. For the different target substances, appropriate MOFs-based materials need to be found as fluorescent probes. In other words, it is necessary to observe the response to the detected materials through such intuitive phenomena as fluorescence enhancement or fluorescence quenching of the MOFs-based materials. Therefore, each material may exist in a different response mechanism. The luminescence of MOFs materials can be modulated by changing organic ligands. Lanthanide metals are also often used as metal ions in the preparation of MOFs.

**Luminescence MOF’s:** In recent years, LMOFs, as one of the more widely used branches of MOFs, have flourished in the fields of optical security displays, biomedical imaging and sensing, and illumination decoration due to their optical tunability and fluorescence diversity, particularly in the field of toxic and hazardous substance detection. LMOF’s has latest advances in sensing applications of hazardous materials, with an emphasis on the influence of composition or structure on the sensing capabilities of LMOFs**.** Various luminescence sensing mechanisms and structure-performance relationships are also briefly described. Additionally, the outlooks and several crucial issues of this area are also noted with the expectation of stimulating more attention on investigating the potential of LMOFs for sensing applications.

**4] MOF AS BIOMARKERS:**

Biomarkers are an index of biological monitoring. The National Research Council (NRC) describes a ‘‘biomarker’’ as an index to reflect the occurrence of a biological system or sample, which can be considered a tool to investigate the relationship between touching external chemicals and health lesions. The International Programme on Chemical Safety put forward a generalized definition of biomarkers as a determined index to reflect the interaction between a biological system and external chemical, physical and biological factors. As incipient biological signals to indicate the toxicological effect of pollutants, biomarkers have been developed and applied by lots of disciplines to generate more and more concern.

Up to the present, the applied sensing systems for biomarkers have focused mainly on all kinds of functional NPs and their nanocomposites. The selected NPs involve metal (Ag, Au, Pd, and Pt), oxide (ZnO, Fe3O4, CoFe2O4) and nonoxide species (CdTe) with special optical, magnetic or electronic properties. These NPs often behave as active components fabricated into host materials including MOFs. In addition, some small molecules are used for sensing markers.

1. **MOF IN ORAL DRUG DELIVERY:**

MOFs possess the unique characteristics of highly ordered structure and large surface area.Their tunable porosity, chemical composition, size and shape, and easy surface functionalization make this large family more and more popular for drug delivery. Drugs can be embedded on the outer surface, or encapsulated into inter pore.

### MOF systems for disease therapies: On account of their advantageous features in drug delivery, MOFs have been explored as favorable DDSs for plenty of diseases, including infections, lung disease, diabetes mellitus, ocular disease and tumors, which have made prominent advance in the past few years via diverse loading methods.

**6] MOF AS GAS STORAGE :**

MOFs are well recognized for gas storage and gas separation, owing to their ultrahigh porosity with surface area ranging from 100 to 10,000 m2/g,tunable pore size of 3 to 100 Å, high thermal stability (up to 500 °C) and even exceptional chemical stability. The establishment of permanent porosity for MOFs was realized in late 1990s,which initiated their applications as adsorbents. The rapidly refreshing records of pore surface area highlight this type of adsorbents very promising for gas processing.

**7] MOF IN BIOMEDICAL APPLICATIONS:**

The critical challenges of MOFs in biomedical applications are not only the precise control of particle size and porosity, but also the effect of surface affinity on their metabolic behaviors in vivo. Significantly, diversified surface functionalization strategies provide operational approaches to improve the physiological/ colloidal stability, to introduce special entities for controlled cargo release and specific targeted recognition, to enhance the catalytic reactivity, and to extend the circulation time. In general, the pendant entities used for surface functionalization can be conjugated to the groups of organic ligands (such as –NH2, –COOH, –N3) and the metal nodes on the surface of MOFs through covalent bonding or strong coordination. Pendant polymers, such as polyethylene glycol (PEG) and liposomes, are commonly used to improve the physiological/colloidal stability and reduce immune response of MOFs. Biomacromolecules, such as nucleic acids, proteins, and peptides, bind to the surface of MOFs through coordination bonds, giving MOFs the abilities of target recognition, bioimaging, analytical detection, and drug delivery. Importantly, supramolecular macrocycles are immobilized on the surface of MOFs through supramolecular interactions to regulate the drug release and reduce the side effects during drug delivery.

**Futuristic perspectives of MOF:**

The future of metal-organic frameworks (MOFs) is promising and exciting, with ongoing research and development expected to lead to numerous advancements and applications. Some of the key areas of focus and potential developments in the future include:

Improved Stability: One of the significant challenges for MOFs is their stability in various environmental conditions. Future research is likely to focus on enhancing the stability of MOFs, making them more robust and suitable for practical applications, even in harsh conditions.

Tailored Functionality: Researchers will continue to design and synthesize MOFs with tailored functionalities. By selecting specific metal ions and organic ligands, they can tune the properties of MOFs for various applications, such as gas storage, catalysis, drug delivery, and sensing.

Green and Sustainable MOFs: As environmental concerns grow, there will be an emphasis on developing green and sustainable MOFs. This might involve using renewable and eco-friendly materials as building blocks for MOFs or developing synthesis methods that have a lower environmental impact.

Industrial Applications: MOFs hold great potential for various industrial applications, such as gas separation, storage, and purification, as well as catalysis and chemical reactions. In the future, we can expect to see MOFs being implemented on a larger scale in industrial processes to improve efficiency and sustainability.

Energy Storage: MOFs with high surface areas and tunable porosity could play a crucial role in energy storage technologies. They might be used for advanced battery materials, supercapacitors, or as storage media for hydrogen and other energy carriers.

Water Harvesting and Purification: MOFs have shown promise in capturing and releasing water molecules from the atmosphere, which could have significant implications for water harvesting in arid regions. Additionally, MOFs' ability to selectively adsorb specific molecules makes them suitable for water purification and desalination processes.

MOFs in Medicine: In the medical field, MOFs could find applications in targeted drug delivery systems, imaging agents, and theranostics (combined therapy and diagnostics). MOFs might enable more efficient and controlled drug release, minimizing side effects and improving treatment outcomes.

MOFs in Electronics and Optoelectronics: MOFs with semiconducting or luminescent properties could be integrated into electronic devices and optoelectronic applications, such as sensors, light-emitting diodes (LEDs), and photodetectors.

Artificial Photosynthesis: MOFs may play a role in developing artificial photosynthesis systems that convert carbon dioxide and water into useful chemicals and fuels using solar energy. These systems could contribute to addressing climate change and energy sustainability.

Space Exploration: MOFs could have applications in space missions, such as gas storage for propulsion systems or as protective materials for sensitive instruments.

**Covalent Organic Frameworks(COFs)**

Covalent organic frameworks (COFs) are a class of materials that form two- or three- dimensional structures through reactions between organic precursors resulting in strong, covalent bonds to afford porous, stable, and crystalline materials. COFs emerged as a field from the overarching domain of organic materials as researchers optimized both synthetic control and precursor selection. These improvements to coordination chemistry enabled non-porous and amorphous organic materials such as organic polymers to advance into the construction of porous, crystalline materials with rigid structures that granted exceptional material stability in a wide range of solvents and conditions. Through the development of reticular chemistry, precise synthetic control was achieved and resulted in ordered, nano-porous structures with highly preferential structural orientation and properties which could be synergistically enhanced and amplified. With judicious selection of COF secondary building units (SBUs), or precursors, the final structure could be predetermined, and modified with exceptional control enabling fine-tuning of emergent properties. This level of control facilitates the COF material to be designed, synthesized, and utilized in various applications, many times with metrics on scale or surpassing that of the current state-of-the-art approaches.

The synthesis of 3D COFs has been hindered by longstanding practical and conceptual challenges until it was first achieved in 2007 by Omar M. Yaghi and colleagues.Unlike 0D and 1D systems, which are soluble, the insolubility of 2D and 3D structures precludes the use of stepwise synthesis, making their isolation in crystalline form very difficult. This first challenge, however, was overcome by judiciously choosing building blocks and using reversible condensation reactions to crystallize COFs.

**Reticular Synthesis**

Reticular synthesis enables facile bottom-up synthesis of the framework materials to introduce precise perturbations in chemical composition, resulting in the highly controlled tunability of framework properties. Through a bottom-up approach, a material is built from atomic or molecular components synthetically as opposed to a top-down approach, which forms a material from the bulk through approaches such as exfoliation, lithography, or other varieties of post-synthetic modification. The bottom-up approach is especially advantageous with respect to materials such as COFs because the synthetic methods are designed to directly result in an extended, highly crosslinked framework that can be tuned with exceptional control at the nanoscale level. Geometrical and dimensional principles govern the framework's resulting topology as the SBUs combine to form predetermined structures. This level of synthetic control has also been termed "molecular engineering", abiding by the concept termed by Arthur R. von Hippel in 1956.

COF topological control through judicious selection of precursors that result in bonding directionality in the final resulting network. Adapted from Jiang and coworkers' Two- and Three-dimensional Covalent Organic Frameworks (COFs).

It has been established in the literature that, when integrated into an isoreticular framework, such as COF, properties from monomeric compounds can be synergistically enhanced and amplified. COF materials possess the unique ability for bottom-up reticular synthesis to afford robust, tunable frameworks that synergistically enhance the properties of the precursors, which, in turn, offers many advantages in terms of improved performance in different applications. As a result, the COF material is highly modular and tuned efficiently by varying the SBUs’ identity, length, and functionality depending on the desired property change on the framework scale. There exists the ability to introduce diverse functionality directly into the framework scaffold to allow for a variety of functions which would be cumbersome, if not impossible, to achieve through a top-down method. such as lithographic approaches or chemical-based nanofabrication. Through reticular synthesis, it is possible to molecularly engineer modular, framework materials with highly porous scaffolds that exhibit unique electronic, optical, and magnetic properties while simultaneously integrating desired functionality into the COF skeleton.

Reticular synthesis is different from retrosynthesis of organic compounds, because the structural integrity and rigidity of the building blocks in reticular synthesis remain unaltered throughout the construction process—an important aspect that could help to fully realize the benefits of design in crystalline solid-state frameworks. Similarly, reticular synthesis should be distinguished from supramolecular assembly, because in the former, building blocks are linked by strong bonds throughout the crystal.

Synthetic Chemistry: Reticular synthesis was used by Yaghi and coworkers in 2005 to construct the first two COFs reported in the literature: COF-1, using a dehydration reaction of benzenediboronic acid (BDBA), and COF-5, via a condensation reaction between hexahydroxytriphenylene (HHTP) and BDBA. These framework scaffolds were interconnected through the formation of boroxine and boronate linkages, respectively, using solvothermal synthetic methods.

COF Linkages: Since Yaghi and coworkers’ seminal work in 2005, COF synthesis has expanded to include a wide range of organic connectivity such as boron-, nitrogen-, other atom-containing linkages.

**Applications of COF:**

1. Gas storage and separation: COFs can be designed with specific pore sizes and geometries, making them promising materials for gas storage and separation applications. They can adsorb and store gases like hydrogen, methane, carbon dioxide, and other environmentally relevant gases.

2. Catalysis: COFs can act as efficient catalysts in various chemical reactions due to their well-defined and accessible active sites. They can catalyze reactions such as hydrogenation, oxidation, and carbon-carbon bond formation.

3. Sensing: The structural flexibility and porosity of COFs allow them to interact with specific analytes, making them suitable for gas sensing and chemical sensing applications.

4. Optoelectronics: COFs with π-conjugated structures can exhibit interesting electronic and optical properties, making them potential candidates for optoelectronic devices such as light-emitting diodes (LEDs) and photodetectors.

5. Energy storage: COFs have shown promise in energy storage applications, particularly in supercapacitors. Their high surface area and tunable pore size can enhance the charge storage capacity.

6. Drug delivery: The porous nature of COFs allows for the encapsulation and controlled release of drugs and other bioactive compounds, making them useful for drug delivery systems.

7. Environmental remediation: COFs can be functionalized to selectively capture and remove pollutants from water and air, aiding in environmental remediation efforts.

8. Membrane technology: COFs can be integrated into membranes to achieve selective separation of molecules in processes such as water purification and gas separation.

9. Flexible electronics: The mechanical flexibility of certain COFs can be utilized to create flexible and stretchable electronic devices.

10. Nanotechnology: COFs can serve as building blocks for nanoscale devices and materials due to their precise structures and well-defined functionalities.

**Conclusion and Perspective:**

As a fast-growing branch of coordination chemistry, metal–organic frameworks (MOFs) and covalent organic frameworks(COFs) with tailorable porous structures and numerous active sites have proved to be ideal material for numerous applications. As a promising class of crystalline porous inorganic–organic hybrid materials, MOFs and COFs can principally incorporate almost infinitely diverse functional components (all kinds of metal ions, organic ligands and guest molecules/ions). More importantly, their porous structures and chemical environments within a cavity are highly designable and can be modulated by following reticular chemistry.

**State of the art:**

MOFs and COFs fabricated from bonds between metal ions and bridging organic ligands are popular among recently studied economical adsorbents,sensing and have many attractive properties. Porous 3D network with extensive surface area, tunable pore size, higher stability, low-cost synthesis, higher efficiency and easy separation made MOFs and COFs a promising next generation material in various fields. Despite their advantages, certain MOFs and COFs display weak properties, including poor water stability and lower thermostability than other materials. To compensate for these deficiencies, a regulated combination of different MOFs/ COFs and building materials are being explored to create better multifunctional units with enhanced properties facilitated through the synergistic effects of the individual units. MOFs/COFs are coated on several membranes to enhance their functionality. Some binary and higher composites are also derived from organic materials like chitosan, dendrimers, cyclodextrin and inorganic frameworks like LDH, zeolites and made certain hybrid materials e.g., binary composites like (cyclodextrin-MOF), (chitosan-MOF),(LDH-MOF),(V2O5-MOF),(LDH-V2O5) and ternary composites (MOF-chitosan-cyclodextrin). These synthesized binary and/or any other higher constitutional composites are aimed to be employed for sensing or adsorption of multivariant pollutants like POP, dioxins, organic insecticides and pesticides.es, V2O5 and many more applications.

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