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Metal-organic frameworks as the basis for new-generation functional materials

In recent decades, a new important area appeared in coordination chemistry. This is the design, synthesis and detailed investigation of metal-organic frameworks (MOFs), or coordination polymers. The search of the Web of Science database shows an exponential growth of the number of relevant publications in recent years (more than 73 000). The Hirsch index only for papers that have the expression 'metal-organic framework' in the title is 420; there are 1983 reviews among these publications. The close attention of researchers to this class of compounds is due to the very broad range of MOFs functional properties and, hence, prospects for high-tech practical applications as components of new-generation functional materials with enhanced or unique characteristics. For example, porous metal-organic frameworks show record-breaking adsorption characteristics among all materials of this type, which dictates their use for compact storage of industrially important hard-to-compress gases (hydrogen, methane, acetylene), purification and separation of complex mixtures, including industrial discharges and biologically active molecules, heterogeneous catalysis, targeted drug delivery and prolongation of drug action and for the development of highly sensitive new type sensors, conductors and so on. A separate important problem is to predict the properties of new MOFs as functions of their structure, in particular, the nature of organic and inorganic components MOFs.

This issue includes three reviews covering the main modern trends in the development of this area. The review by Corresponding Member of the RAS V.P.Fedin and co-workers describes strategies and approaches to the development of new porous MOFs as a base for highly efficient and highly selective sorbents for the separation of valuable industrial raw materials such as light hydrocarbons and mixtures of hydrocarbons with similar boiling points and molecule sizes. The review by Professor V.A.Blatov and co-workers is devoted to full systematization of the topological types of metal-organic frameworks and development of mathematical approaches for the prediction of structure and properties of metal-organic frameworks: the search for chemical composition – structure – property relationships and development of databases and artificial intelligence systems. Particular attention is paid to the properties of proton-conducting metal-organic frameworks, which have been actively studied in the last decade due to the need to find components for new alternative energy sources.

The possibility of varying the properties and potential applications of metal-organic frameworks depending on the nature of the bridging organic ligand and inorganic component is demonstrated in the review by Corresponding Member of the RAS Yu.G.Gorbunova and co-workers in relation to porphyrin ligands. The unique properties of these macrocyclic organic compounds considerably expand the scope of potential applicability of porphyrin-based MOFs in comparison with the traditional metal-organic frameworks. For example, the review gives data on the application of porphyrin-based MOFs in heterogeneous catalysis and photocatalysis, photocatalytic hydrogen generation, electrochemical reactions, utilization of CO_2, photodynamic therapy of cancer and numerous other applications.

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