Organic Chemistry
Current Research
ISSN: 2161-0401

Vijaya Krishna, Organic Chem Current Res 2012, 1:1
DOI: 10.4172/2161-0401.1000e101

Editorial Open Access

Molecularly Imprinted Polymers: The Way Forward

Vijaya Krishna Varanasi*

Washington State University, USA

Editorial

Open Access has become a passionately discussed topic all over the world. Open Access can be defined as a 'global public good': an instrument to stimulate the growth and quality of global science, as well as an instrument for realizing the rights to share in scientific advancement and its benefits, to education and to information (articles 27, 26 and 19 of the Universal Declaration of Human Rights respectively) [1]. Open Access (OA) journals such as "Organic Chemistry: Current Research" (OCCR) from OMICS Publishing Group allow researchers to maximize dissemination of their work by reaching the largest possible readership. Articles published in open access format are more likely to be cited than those that are not [2]. Due to this reason impact factor of open access journals is on the rise for the last couple of years [3]. Researchers in developing nations are more likely to access information published by OA journals. OMICS Publishing Group strongly supports the open access initiative and all articles published by OMICS Publishing Group are freely accessible to everyone immediately after publication. Some of the special features of OMICS group journals include digital formatting, audio listening, language translation and ability to share views on articles via social networking. The journal, "Organic chemistry: Current Research" covers all aspects of organic chemistry, including organic synthesis, organic reactions, natural product chemistry, structural investigations, supramolecular chemistry and chemical biology. The knowledge and expertise of the editors and editorial board members of OCCR ensures high quality research articles and allows for a comprehensive review of scholarly works which will act as a reliable source of information on current developments in Organic chemistry.

Since the seminal work of Polyakov in the 1930s [4], using silica matrices, the concept of a molecularly imprinted polymer has evolved to include a vast array of organic polymers and polymer formats. Molecularly imprinted polymers (MIPs) are highly stable synthetic polymers that possess recognition sites that are specific to the three-dimensional (3-D) shape and functionalities of a target of interest [5]. MIP is generally described as a plastic cast or mold of the molecule of interest, where recognition is based on shape, much like a lock and key. MIPs can be synthesized in a covalent or a non-covalent fashion. Molecular covalent imprinting involves chemical coupling of the template with one of the building blocks of the polymer, and after the polymerization process is complete, the resulting bond is cleaved to obtain free selective binding sites. Non-covalent imprinting is the most popular approach nowadays based upon self-assembly between the template and carefully selected functional monomers. After polymerization in the presence of a crosslinking monomer, the template is removed from the polymer and the resulting polymer will contain a recognition site with functional groups in a defined 3-D array. MIPs are highly selective for the target molecule used in the imprinting process. This selective recognition power of molecularly imprinted polymers depends on the morphology and the number of functional groups of the template [6]. An increasing number of interacting functional groups in a molecule will increase its selectivity, whereas site accessibility and the mass transfer properties of the sorbent depend upon the morphology. MIPs have the ability to recognize one or a group of analytes depending upon the choice of template.

Molecular imprinting technology is an approach to design robust molecular recognition materials able to mimic natural recognition entities, such as antibodies and biological receptors [7]. MIPs can recognize both biological and chemical molecules such as amino acids and proteins [8], various nucleotide and their derivatives [9], pollutants [10], drugs and food [11]. MIPs have wide range of applications and are used in separation and purification sciences [12], chemical sensors [13], catalysis [14], drug delivery [15], biological antibodies and receptors systems [16]. MIPs compared to other biological systems, are less expensive, more robust, have higher strength, withstand elevated temperatures and pressures and are chemically inert towards acids, bases, metal ions and organic solvents [17]. Relative to other systems, MIPs also have longer shelf life at room temperature.

Water pollution is a major global concern which requires ongoing evaluation and revision of water resource policy at all levels (international down to individual aquifers and wells). It has been suggested that it is the leading cause of deaths and diseases worldwide. According to a recent national report on water quality in the United States, 45% of assessed stream miles, 47% of assessed lake acres, and 32% of assessed bay and estuarine square miles were classified as polluted [18]. Molecular imprinting technology has the ability to remove Highly Toxic Organic Pollutants (HTOPs) from polluted water bodies. As a result of various human activities, organic compounds enter lakes, rivers, oceans and groundwater causing contamination of water and endangering the environment in which we live. United States Environmental Protection Agency (USEPA) has listed different chemicals found in water as priority chemicals on the basis of criteria such as toxicity, carcinogenicity, degradability etc [19]. The use of MIPs for treating waste water has two major limitations [20]: (i) MIPs are not compatible with aqueous media and (ii) some targets are difficult to be used as templates. One of the major drawbacks in the use of MIPs in polluted water is that they exhibit poor molecular recognition in aqueous media. Various solutions have been put forward to solve these problems. The nonspecific adsorption in aqueous media can be reduced by coating a hydrophilic external layer onto MIPs [21] or by using water soluble polymers via an interval immobilization technique [22]. Recently, an interfacial imprinting was developed in Pickering emulsions to generate water-compatible MIPs, where the molecular template was presented on the surface of silica nanoparticles [23]. Use of more hydrophilic monomers to synthesize water compatible MIPs has also been suggested [24]. If suitable systems are developed

***Corresponding author:** Vijaya Krishna Varanasi, Post doctoral research, Washington State University, USA, E-mail: vijaya.varanasi@gmail.com

Received January 09, 2012; **Accepted** January 11, 2012; **Published** January 14, 2012

Citation: Vijaya Krishna V (2012) Molecularly Imprinted Polymers: The Way Forward. Organic Chem Current Res 1:e101. doi:10.4172/2161-0401.1000e101

to mimic the biological recognition process, water mediated molecular recognition should be viable.

The second major issue with MIPs is that some targets are difficult to be used as templates in the imprinting process as they have either very high toxicity or low solubility in the polymerization solution [20]. One of approaches suggested to counter this problem is to use analogues complementary to substructures of the target in which appropriate templates were selected as alternatives to the target substrates, named as structural analogues or pseudo-templates [25]. Another approach known as fragment imprinting technique uses templates possessing hydrogen bondable functional groups that could substitute the real templates in the preparation of MIPs [26]. Fragment imprinting technique is an efficient method to prepare MIPs with specific recognition ability to many water pollutants.

Following challenges exist in the successful use of MIPs for management of waste water: (i) In situ regeneration of MIPs which have fully adsorbed the target pollutants (ii) Synthesis of MIPs which are compatible in water and (iii) Increasing the stability and duration of MIPs in highly reactive environments. Use of advanced oxidation processes (AOPs) should be promoted for treating biologically toxic or non-degradable organic pollutants present in waste water [20]. The integration of available molecular imprinting technology with AOPs (for example MIPs-TiO_2) might be the best approach for removing pollutants from water bodies. A number of significant fundamental challenges regarding the mechanisms underlying the imprinting technique remain to be explored and many opportunities for applications are still to be exploited. I am confident that the journal "Organic chemistry: Current Research" from OMICS Publishing Group will not only act as a platform for addressing some of the above key issues in the use of MIPs in mitigating environmental pollution but also their applications in other areas such as food and drug industries.

References

1. A Global Perspective on Open Access (2011) UNESCO.
2. MacCallum CJ, Parthasarathy H (2006) Open access increases citation rate. PLoS Biol 4: 176.
3. BioMed Central. Open access journals get impressive impact factors; journals published by BioMed Central get new impact factors from ISI.
4. Polyakov MV (1931) Adsorption properties and structure of silica gel. Zhur Fiz Khim 2: 799–805.
5. Ramstrom O, Mosbach K (1999) Synthesis and catalysis by molecularly imprinted materials. Curr Opin Chem Biol 3: 759-764.
6. Sellergren B, Lepistö M, Mosbach K (1988) Highly Enantioselective and Substrate-Selective Polymers Obtained by Molecular Imprinting Utilizing Noncovalent Interactions. NMR and Chromatographic Studies on the Nature of Recognition. J Am Chem Soc 110: 5853-5860.
7. Mosbach K, Ramstrőm O (1996) The emerging technique of molecular imprinting and its future impact on biotechnology. Nat Biotechnol 14: 163-170.
8. Bossi A, Bonini F, Turner APF, Piletsky SA (2007) Molecularly imprinted polymers for the recognition of proteins: The state of the art. Biosens Bioelectron 22: 1131-1137.
9. Longo L, Vasapollo G (2008) Molecularly imprinted polymers as nucleotide receptors. Mini Rev Org Chem 5: 163-170.
10. Pichon V, Chapuis-Hugon F (2008) Role of molecularly imprinted polymers for selective determination of environmental pollutants—A review. Anal Chim Acta 622: 48-61.
11. Baggiani C, Anfossi L, Giovannoli C (2007) Solid phase extraction of food contaminants using molecular imprinted polymers. Anal Chim Acta 591: 29-39.
12. Andersson LI (2000) Molecular imprinting: Developments and applications in the analytical chemistry field. J Chromatogr B 745: 3-13.
13. Piletsky SA, Turner NW, Laitenberger P (2006) Molecularly imprinted polymers in clinical diagnostics-future potential and existing problems. Med Eng Phys 28: 971-977.
14. Li W, Li S (2007) Molecular imprinting: A versatile tool for separation, sensors and catalysis. Adv Polym Sci 206: 191-210.
15. Puoci F, Iemma F, Picci N (2008) Stimuli-responsive molecularly imprinted polymers for drug delivery: A review. Curr Drug Deliv 5: 85-96.
16. Longo L, Vasapollo G (2008) Phthalocyanine-based molecularly imprinted polymers as nucleoside receptors. Met-Based Drugs 2008: 1-5.
17. Vasapollo G, Del Sole R, Mergola L, Lazzoi MR, Scardino A, et al. (2011) Molecularly Imprinted Polymers: Present and Future Prospective. Int J Mol Sci 12: 5908-5945.
18. United States Environmental Protection Agency (EPA) (2007) The National Water Quality Inventory: Report to Congress for the 2002 Reporting Cycle – A Profile. Fact Sheet No. EPA 841-F-07-003.
19. Schafer RB, von der Ohe PC, Kühne R, Schüürmann G, Liess M (2011) Occurrence and toxicity of 331 organic pollutants in large rivers of North Germany over a decade (1994 to 2004). Environ Sci Technol 45: 6167-6174.
20. Shen X, Zhu L, Wang N, Ye L, Tang H (2012) Molecular imprinting for removing highly toxic organic pollutants. Chem Commun 48: 788-798.
21. Haginaka J, Takehira H, Hosoya K, Tanaka K (1999) Uniform-sized molecularly imprinted polymer for (S)-naproxen selectively modified with hydrophilic external layer. J Chromatogr A 849: 331-339.
22. Tominaga Y, Kubo T, Kaya K, Hosoya K (2009) Effective recognition on the surface of a polymer prepared by molecular imprinting using ionic complex. Macromolecules 42: 2911-2915.
23. Shen X, Ye L (2011) Interfacial Molecular Imprinting in Nanoparticle-Stabilized Emulsions. Macromolecules 44: 5631-5637.
24. Bolisay LD, Culver JN, Kofinas P (2006) Molecularly imprinted polymers for tobacco mosaic virus recognition. Biomaterials 27: 4165-4168.
25. Quaglia M, Chenon K, Hall AJ, De Lorenzi E, Sellergren B (2001) Target Analogue Imprinted Polymers with Affinity for Folic Acid and Related Compounds. J Am Chem Soc 123: 2146-2154.
26. Kubo T, Hosoya K, Sano T, Nomachi M, Tanaka N, et al. (2005) Selective separation of brominated bisphenol A homologues using a polymer-based medium prepared by the fragment imprinting technique. Anal Chim Acta 549: 45-50.