www.amlett.com, DOI: 10.5185/amlett.2010.1201 Published online by the VBRI press in 2010

Molecularly imprinted sensors

Dear Readers

There is tremendous interest by society in reliable and affordable sensors and sensing systems, ranging from environmental monitoring and protection to pharmaceutical separation and analysis, and from defense and security to medicine and healthcare. The emerging challenges associated with public exposure to pollution and hazardous substances have fuelled an urgent need for novel sensors and detection technologies. Scientists in this field have been working under pressure to meet these challenges over the past few years. A large body of knowledge in sensors and sensing systems are now available; however, most of them cannot straightforwardly lead to reliable, stable, reproducible, highly specific and sensitive sensing and detection. In fact, there are also significant challenges in the preparation of these sensors, which is usually extremely complicated and needs careful and time-consuming processing. Thus, novel technologies and sensing materials are being badly needed. Known as a 'plastic antibody' technology, the latest development of molecular imprinting appears to provide a key solution to the stranded sensing field.

Inspired by the mechanism of antibody/antigen recognition, molecular imprinting is capable of straightforwardly creating binding sites for desired templates that are comparable to natural antibodies. The initially explosive growth in molecularly imprinted polymers (MIPs) in 1980s and 1990s was due in large part to the pioneering efforts of Professor Günter Wulff, Heinrich Heine University, Düsseldorf, Germany and Professor Klaus Mosbach, Lund University, Sweden for their discoveries in covalent and non-covalent imprinting in synthetic polymers respectively. During the fabrication process, the template and functional monomers are first allowed to form a self-assembled architecture where the functional monomers are regularly positioned around the template. Polymerization is then performed to fix this self-organized architecture in place, followed by removal of the imprinted template from the polymeric networks, which thereby leaves behind binding sites stereochemically complementary to the template. In this way, the match between the template and binding sites constitutes an induced memory, which makes the prepared imprinted polymers capable of recognizing the imprint species. In comparison with biogenic antibodies, molecularly imprinted materials have the merits of easy preparation, reusability and robustness for chemical and physical stresses. As such, molecularly imprinted materials can be used under hard conditions, such as resistance to elevated temperature and pressure, and inertia to acid, base, metal ion, organic solvent, *etc*.

Molecularly imprinted sensors are the emerging field in molecular imprinting, which was pioneered by Professor Sergey A. Piletsky and his research group (Cranfield University, UK), which is currently ranked the top research group of molecular imprinting around the world, regarding the number of publications and patents (cf. appended statistics). Because of the excellent properties of MIPs, molecularly imprinted sensors usually demonstrate cheapness, easier preparation, better reusability and broader applicable ranges. Recently, the field of molecularly imprinted sensors is further underpinned by the adoption of nanosized imprinted materials. The use of nanosized imprinted materials enable compactness, significantly increased specific surface area and better accessibility to the 'imprint', which thus lead to fast equilibration with analytes. To some extent, molecularly imprinted sensors can be recognized as an emerging revolution in the sensing field, which is profoundly changing the conventional understanding of the basic concept of 'sensors'.

Appendix: Top 6 groups of molecular imprinting around the world*

Rank	Group	Affiliation	Number of papers and patents
1	Sergey A. Piletsky	Cranfield University, UK	80
2	Börje Sellergren	Technical University of Dortmund, Germany	35
3	Franz L. Dickert	University of Vienna, Austria	35
4	Adil Denizli	Hacettepe University, Turkey	33
5	Yukui Zhang	Dalian Institute of Chemical Physics, Chinese Academy of Sciences, China	32
6	Karsten Haupt	Compiègne University of Technology, France	31

*Statistical data provided by the famous MIP database (http://www.mipdatabase.com) and covered the date from 2001 to 2010.

With kindest regards,

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