Optical detection of human hemoglobin by a molecularly imprinted polymer prepared by a novel vapor-phase synthesis

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Molecularly imprinted polymers (MIPs) are synthetic materials with marked recognition capabilities like those of the natural receptors. However, compared to biological recognition elements such as enzymes, proteins and antibodies, MIPs are stable at harsh conditions, easy to synthesize, and inexpensive. Today these materials are used for a wide variety of purposes, from environmental to clinical/medical applications. Now, technological advancement leads to the need to couple these artificial receptors with miniaturized and complex systems. Application of MIPs to nanostructured materials is challenging due to diffusion-limited transport of monomers within the nanomaterial recesses, especially when the aspect ratio is >10. The room temperature vapor-phase synthesis of MIPs in nanostructured materials was explored. The vapor phase synthesis leverages a >1000-fold increase in the diffusion coefficient of monomers in vapor phase, compared to liquid phase, to relax diffusion-limited transport and enable the controlled synthesis of MIPs also in nanostructures with high aspect ratio. As proof-of-concept application, pyrrole is used as the functional monomer thanks to its large exploitation in MIP preparation; nanostructured porous silicon oxide ($nPSiO_2$) is chosen to assess the vapor-phase deposition of PPy-based MIP in nanostructures with aspect ratio >100; human hemoglobin (HHb) is selected as the target molecule for the preparation of a MIP-based $nPSiO_2$ optical sensor. High sensitivity and selectivity, low detection limit, high stability and reusability are achieved in label-free optical detection of HHb, also in human plasma and artificial serum. The proposed vapor-phase synthesis of MIPs is immediately transferable to other nanomaterials, transducers, and proteins.

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