Smartphone-assisted Detection by diffractive sensors : a fruitful combination of Soft Chemistry & Soft Lithography

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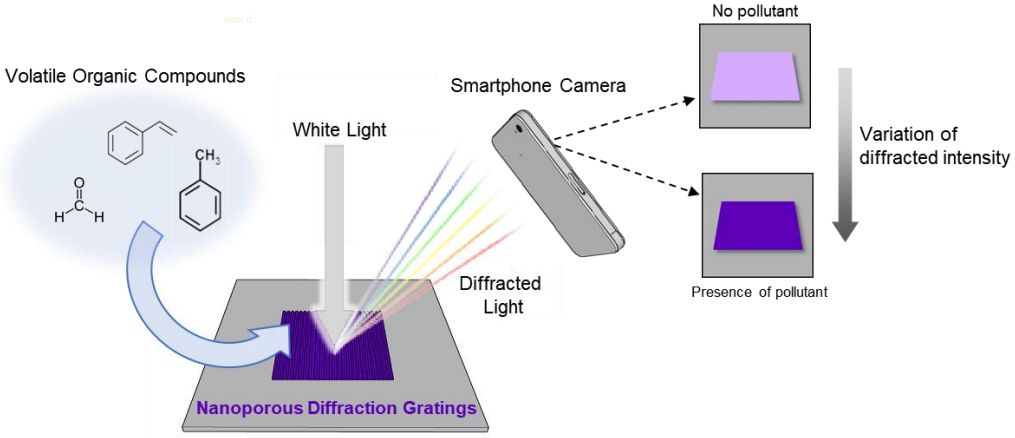
The ubiquitous presence of Volatile Organic Compounds (VOC) at low concentration in indoor atmosphere is a serious health issue due to the chronic exposition to those carcinogenic agents. My PhD thesis focused on the fabrication of optical sensors based on hybrid nanoporous thin films. They are able to give an optical signal straightforwardly measured by a simple CCD camera, such as a smartphone camera. We fabricated diffraction gratings integrating nanoporous Metal-Organic Frameworks (MOF) nanoparticles. MOF were selected as sensing materials because of their high specific surface area (>1000$m^2.g^{-1}$) and their selectivity towards adsorption of VOC.



First, we achieved the selective sensing of styrene from a styrene/water mixture used for the industrial synthesis of polystyrene beads in emulsion. The passive TiO_2 gratings are covered by ZIF-8 nanoparticles. Hydrophobic micropores of ZIF-8 selectively adsorb the styrene from the humid atmosphere. The variation of diffracted intensity allowed the sensing of styrene at concentrations as low as 57 ppm which is below the Permissible Exposure Limit (100 ppm)[1].
A major improvement of the sensing approach was then proposed by using Evaporation-Directed Crack Patterning. This non-lithographic technique is used to fabricate micronic diffractive patterns on large and on non-planar substrates. By-passing the lithographic microfabrication techniques makes this patterning process truly low-cost and scalable. By monitoring the diffraction figure obtained from a commercial laser, sensing of toluene at low concentrations (150 ppm) was achieved with a direct readout from a smartphone camera[2]. With this, we demonstrate the fabrication of low-cost optical sensors readable by smartphones, paving the way for a simple detection accessible to everyone, at home or at work.

[1] O. Dalstein, D.R. Ceratti, C. Boissière, D. Grosso, A. Cattoni, M. Faustini, *Adv Func Mat*, **2016**, *26*, 81-90
[2] O. Dalstein, E. Gkaniatsou, C. Sicard, O. Sel, H. Perrot, C. Serre, C. Boissière, M. Faustini, *Angew Chem Int Ed*, **2017**, *56*, 14011-14015