

# Smart Sensors for Civil Security Applications

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In recent years, attention has been focused on the efficient detection of chemical pollutants, especially small volatile organic compounds (VOCs) and hazardous gases (HGs), as well as bacterial agents [1]. This area is very challenging because such molecules are relatively volatile at room temperature, even at low concentration levels. Such species can enter the body through normal breathing, and cause serious health issues [2]. Our investigations led us to focus on a series of azole based coordination polymers [3], for which intriguing iron(II) spin crossover properties were disclosed [4]. In particular, we have recently identified a new colorimetric chemosensor of formula  $[\text{Fe}(\text{H}_2\text{btm})_2(\text{H}_2\text{O})_2]\text{Cl}$  (**1**) ( $\text{H}_2\text{btm}$  = di(1H-tetrazol-5-yl)methane), allowing to detect at real time, with a high selectivity and ultra-sensitivity, 14 different VOCs and HGs [2]. In particular amines, which are detected very quickly (< 2 min) with very high sensitivity. The detection is accompanied by significant and fast colour changes detectable by the naked-eye at ambient conditions. In addition, different VOCs could be distinguished by simple and intuitive standard chemometric means using a handful smartphone-based analytical method, offering a large colour panel depending on detected molecules. The crystal lattice of (**1**) reconstructs after adsorbing VOCs vapours, reconstruction which is accompanied by a spin state and a colour change. In addition to its high thermal stability (up to 170 °C), the colorimetric sensor showed excellent reusability by consecutive 7 cycles of adsorption–desorption. This sensor is low-cost, environmentally friendly, easy to use, and shows excellent and fast detection performances. Such features offer attractive prospects for (**1**) which could be used for in-field detection and food safety control in environmental conditions. In this invited talk, I will review latest advances highlighting the impact of  $^{57}\text{Fe}$  Mössbauer spectroscopy for quantitative analysis of spin states of selected iron(II) complexes, used as sensors for various toxic industrial chemicals (TICs) [5-11].

1. Chkirate K., Karrouchi K., Dege N., Sebbar N. K., Ejoumany A., Radi S., Adarsh N. N., Talbaoui A., Ferbinteanu M., Essassi E. M., Garcia Y., *New. J. Chem.* 44 (2020) 2210. **Front cover**.
2. L. Sun, A. Rotaru, K. Robeyns, Y. Garcia, *Ind. Eng. Chem. Res.* 60 (2021) 8799.
3. Y. Garcia, *Adv. Inorg. Chem.* 76 (2020) 121.
4. S. Xue, Y. Guo, Y. Garcia, *CrystEngComm* 23 (2021) 7899 - 7915. **Highlight**
5. Y. Guo, S. Xue, M. M. Dîrtu, Y. Garcia, *J. Mater. Chem. C* 6 (2018) 3895-3900.
6. S. Xue, L. Wang, A. D. Naik, J. Oláh, K. Robeyns, A. Rotaru, Y. Guo, Y. Garcia, *Inorg. Chem. Front.* 8 (2021) 3532.
7. L. Sun, W. Li, Y. Garcia, *Möss. Eff. Ref. Data J.* 45 (2022) 47-49.
8. L. Sun, W. Li, Y. Garcia, Willey VCH Book chapter (Y. Garcia, J. Wang, T. Zhang, Eds, 2023).
9. W. Li, L. Sun, Y. Garcia, *Hyperfine Interact.* 242 (2022) 7.
10. W. Li, L. Sun, C. Liu, A. Rotaru, K. Robeyns, M. L. Singleton, Y. Garcia, *J. Mater. Chem. C* (2022, in press). **Hot paper**.
11. L. Sun, A. Rotaru, Y. Garcia, *J. Hazardous Mater.* (2022, in press).

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