Dr ABHISHEK KUMAR

Institut de Chimie Moléculaire de l'Université de Bourgogne (ICMUB)

UMR CNRS 6302 – Dijon – France

abhishek.kumar@u-bourgogne.fr; abhishekarsd@gmail.com

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Postdoctoral researcher:
- Jan. 2020 to present: ICMUB, Dijon, France, Electrografting of functional organic nanomaterials for chemical sensors development (Supervisor: Prof. Marcel Bouvet)
- 2016-2019: Sao Paulo University, Brazil (FAPESP Fellow), Development of multifunctional nanomaterials and their electrochemical characterization in microfluidics coupled SECM: Environmental and biochemical applications (Supervisor: Prof. Mauro Bertotti)

Ph.D. 2012-2015: Institute Pascal, Blaise Pascal University, Metallophthalocyanines based microsensors for BTX monitoring in air (Supervisors: Dr. Christelle Varenne, Dr. Jerome Brunet)

Graduated (Master) in Nanoscience and Nanotechnology, specialization: nanophysics from Grenoble Alpes University (Egide-Eiffel Scholarship) and Delhi University (Exchange Program) (2009-2012), with 3 internships (ICMUB Dijon and ENS Cachan, France, and IISER-Kolkata, India)

Publications: 17 in peer reviewed scientific journals (10 as a first and corresponding author, > 230 citations), ACS Sensors 2020 (10.1021/acssensors.0c00877), Adv. Electron. Mater. 2020 (10.1002/aelm.202000812), Electrochim. Acta 2019 (10.1016/j.electacta.2019.134984), Sens. Actuators 2018 (10.1016/j.snb.2018.02.125)

Molecular semiconductors based organic heterojunction devices for redox gases detection

My research area deals with the development of redox **gas sensors** incorporating two different MPc in a bilayer organic heterojunction device structure. In the device, top layer is high conducting (larger charge carriers' concentration) and sublayer is poor conducting (low charge carrier concentration). The strategy of adopting such a device configuration is to benefit from organic heterojunction effect, which enhances manifold the charge carriers (e^- or h^+) mobility at the interface. **Organic heterojunction** is formed by combining two organic semiconducting materials with widely varied workfunction (Φ) in a bilayer arrangement. Because of the accumulation of charges close to the interface, trap states are filled, and interface becomes highly conducting. The nature of the **interfacial charge transport** is different from those in bulk because charges are delocalized and move like a free carrier, while in the bulk, charges move by hopping process, which limits their mobility. The interfacial charges alignments and the associated threshold voltage have profound implication on the redox gases sensing properties devices.

Beside **phthalocyanines** CuPc and Cu(F_{16}Pc), well-known as p-type and n-type materials, we studied octahalogenated derivatives, M(X_8Pc) (X = F, Cl). In this series, central metal atom has a strong influence on the electrical properties of related heterojunction device and ultimately affects the NH_3 sensing. Opposite trend in current variations is noted in Cu(Cl_8Pc)/$LuPc_2$ and Co(Cl_8Pc)/$LuPc_2$ heterojunctions for alternate exposure to NH_3 at 90 ppm and recovery in clean air, exhibiting p-type and n-type semiconducting polarity, respectively, for these two devices. Interestingly, Co(Cl_8Pc) device showed better NH_3 sensing performance demonstrated by higher sensitivity and lower detection limit and longer linear range than Cu(Cl_8Pc)/$LuPc_2$, making it among the best NH_3 sensors reported. Moreover, the device is stable in a wide range of relative humidity highlighting its potentiality to be used in real environmental condition.

My research works are ongoing to tune the interfacial properties of organic heterojunction devices by **electrografting** for achieving optimum sensing performances towards redox gases. Such strategy is highly promising for **ambipolar devices** development, having e^- and h^+ carriers near equilibrium, and a slight charge doping from an external trigger (light, chemical species, bias) can shift the equilibrium in either direction.

References: G. Bengasi, et al., Molecular Engineering of Porphyrin-Tapes/Phthalocyanine Heterojunctions for a Highly Sensitive Ammonia Sensor, Adv. Electron. Mater., 6, 2000812, **2020**. doi: 10.1002/aelm.202000812; A. Kumar, et al., Organic heterojunction devices based on phthalocyanines: A new approach to gas chemosensing, Sensors, 20, 4700, **2020**. doi:10.3390/s20174700; S. Ouedraogo, et al., Modulating the electrical properties of organic heterojunction devices based on phthalocyanines for ambipolar sensors, ACS Sensors, 5(6) 1849–1857, **2020**. doi.10.1021/acssensors.0c00877