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Sensor Group, UCT Prague: Research Topics and Experimental Facilities

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The Sensor Group at the University of Chemistry and Technology in Prague focuses on the research and development of chemical gas sensors. Based within the Department of Physics and Measurements, our work encompasses the preparation and characterization of thin-film structures for sensor applications. We explore a wide range of materials, including nanostructured and nanoporous systems such as black metals, inorganic and organic semiconductors, polymer ionic liquids, and composite materials.
Our research is supported by advanced fabrication techniques, including Physical Vapor Deposition (PVD) systems such as Pulsed Laser Deposition (PLD), Magnetron Sputtering, Thermal Evaporation or sytsem for Laser-Induced Forward Transfer (LIFT). Beyond material synthesis, we investigate sensor-gas interactions through electrical, optical, and surface analysis to optimize sensor performance.
The applications of our work span multiple areas, including security systems for the detection of hazardous substances, industrial gas monitoring, and environmental pollution sensing. This talk will provide an overview of our research activities, key focus areas, and the experimental facilities available within our group.

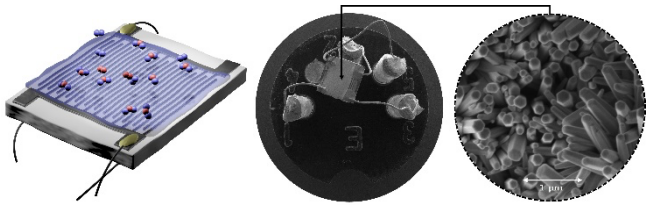

Fig. 1: 3D Scheme and SEM Image of Chemiresistor with Semiconductive ZnO Active Layer

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Utilisation of nanostructured and nanoporous materials for chemical gas sensors

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This talk will present a summary of my PhD research, which explored the use of highly nanoporous black metals (BMs) as sensitive films for chemical gas sensors. The study focused on enhancing the sensitivity of quartz crystal microbalance (QCM) sensors by increasing their effective surface area and investigating the functionalisation of BM layers with additional receptors. A key finding was that nanostructured black metals can also exhibit high resistance, making them suitable for chemiresistor applications.
In addition to sensor applications, the research examined the fabrication of black metal films, highlighting the role of deposition conditions in their nanostructuration. Further thermal and laser treatments were explored to tailor their morphological and physical properties. A significant challenge addressed in this work was the damping effect on QCM oscillations caused by black metal coatings. This issue was tackled using real-time in-situ QCM-impedance analysis (QCM-IA), supported by a newly developed fitting algorithm. The impact of the surrounding atmosphere on

QCM damping was also investigated. The talk will provide an overview of these key findings and their implications for sensor development.

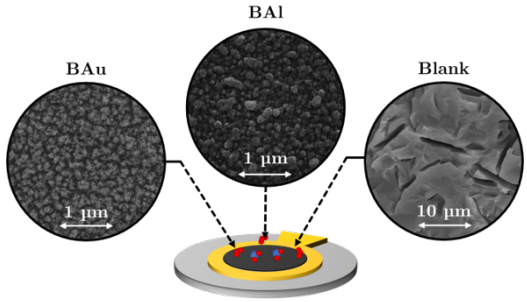

Fig. 1: Illustration of QCM with different black metal coatings

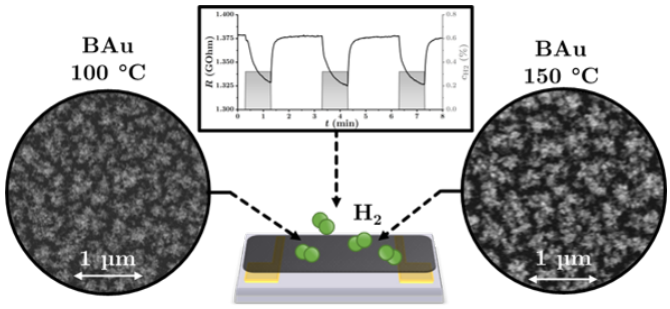

Fig. 2: Illustration of chemiresistor with black gold film for hydrogen sensing

References

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2. Hydrogen sensing capabilities of highly nanoporous black gold films. Hruška, M.; Kejzlar, J.; Otta, J.; Fitl, P.; Novotný, M.; Čížek, J.; Melikhova, O.; Mičušík, M.; Machata, P.; and Vrňata, M. Applied Surface Science, 647: 158618. 2 2024. http://doi.org/10.1016/j.apsusc.2023.158618
3. Surface Enhancement Using Black Coatings for Sensor Applications. Hruška, M.; More-Chevalier, J.; Fitl, P.; Novotný, M.; Hruška, P.; Prokop, D.; Pokorný, P.; Kejzlar, J.; Gadenne, V.; Patrone, L.; Vrňata, M.; and Lančok, J. Nanomaterials MDPI, 12(23): 4297. 12 2022. http://doi.org/10.3390/NANO12234297