SYNTHESIS AND APPLICATION OF AU-DECORATED 2D MXENE FOR THE PLASMONIC SENSING OF MERCURY IONS IN WATER

Saqib Ali[1], Martynas Talaikis[2], Oleksiy Gogotsi[3], Arunas Ramanavicius[4], Simonas Ramanavicius[1]

[1]State Research Institute Center for Physical Sciences and Technology (FTMC), Department of Electrochemical Materials Research, Sauletekio av. 3, LT-10257 Vilnius, Lithuania
[2]State Research Institute Center for Physical Sciences and Technology (FTMC), Department of Organic Chemistry, Sauletekio av. 3, LT-10257 Vilnius, Lithuania
[3]Materials Research Center, Krzhizhanovskogo street, 3, 03680, Kyiv, Ukraine
[4]State Research Institute Center for Physical Sciences and Technology (FTMC), Department of Nanotechnology, Sauletekio av. 3, LT-10257 Vilnius, Lithuania
saqib.ali@ftmc.lt

Recent industrial development improves human quality of life, meanwhile posing a significant threat to the environment due to the involvement of synthetic chemicals and complex chemical procedures. Industrial effluents are the greatest source of heavy metal ions leaching into the aquatic system. Heavy metal ions are toxic even at low concentrations. Dissoled metal ions are among the most difficult contaminants to identify and remove from water[1]. Currently, lab-based detection technologies are used to secure the water supply for human consumption. There is a need to develop easy-to-use, field-deployable detection technologies. Plasmonic sensors are an emerging area of research for environmental applications, particularly in water quality testing, as they offer high sensitivity and selectivity. Advanced nanomaterials, such as 2D materials, have significantly advanced plasmonic sensor technology [2][3]. Herein, we demonstrated gold-functionalized 2D MXene synthesized at room temperature as a plasmonic sensor for the detection of trace amounts of Hg^{2+} metal ions in water. The detection mechanism relies on the adsorption of Hg^{2+} ions onto the gold-modified MXene surface, which alters its Localized Surface Plasmon Resonance (LSPR)[4]. The plasmonic sensor developed in this study showed a linear response to a change in the Hg^{2+} ions concentration up to 1 ppm in water. The LSPR signal at 580 nm exhibited a progressive redshift in λmax up to 20 nm. The MXene-based plasmonic sensors demonstrated high selectivity against competing metal ions in tap water. In conclusion, this research expands the application of MXene in versatile plasmonic sensor applications.

Keywords: Plasmonic Sensors, MXene, Water Quality, Heavy Metal Ions, 2D Materials

[1] N. Sharma, D. Yadav, M. Shandilya, A. Thakur, and C. M. Srivastava, “Ferrite-based hybrid structures for heavy metal ions removal,” Nanoferrites for Emerging Environmental Applications, pp. 161–175, Jan. 2025, doi: 10.1016/B978-0-443-22232-0.00008-3
[2] F. Q. Yang and L. Ge, “Colorimetric Sensors: Methods and Applications,” Sensors 2023, Vol. 23, Page 9887, vol. 23, no. 24, p. 9887, Dec. 2023, doi: 10.3390/S23249887
[3] I. Navitski, A. Ramanaviciute, S. Ramanavicius, M. Pogorielov, and A. Ramanavicius, “MXene-Based Chemo-Sensors and Other Sensing Devices,” Nanomaterials 2024, Vol. 14, Page 447, vol. 14, no. 5, p. 447, Feb. 2024, doi: 10.3390/NANO14050447
[4] S. Adomavičiūtė-Grabusovė, S. Ramanavičius, A. Popov, V. Šablinskas, O. Gogotsi, and A. Ramanavičius, “Selective Enhancement of SERS Spectral Bands of Salicylic Acid Adsorbate on 2D Ti3C2Tx-Based MXene Film,” Chemosensors 2021, Vol. 9, Page 223, vol. 9, no. 8, p. 223, Aug. 2021, doi: 10.3390/CHEMOSENSORS9080223