Contribution ID: **35** Type: **Oral talk**

Enhancement of chiral sensing with plasmonics meta-gratings

Tuesday, 10 June 2025 12:10 (20 minutes)

Chirality refers to the property of an object that cannot be superimposed on its mirror image. Despite having the same chemical structure, most chiral molecules, also known as enantiomers, exhibit significant differences in biological activity, being either the poison or the drug, depending on their handedness [1]. Detection and separation of chiral molecules are crucial across various fields, including pharmacology, environmental science, and the food industry. The major challenge during the measurement of chiral substances lies in detecting extremely weak chiroptical signals from small concentrations of molecules. Optical plasmonic sensors, based on an angle-resolved surface plasmon resonance, enable precise identification and quantification of the correct isomer in a test substance in a real-time regime [2], which is essential for the safety and efficiency of the pharmaceutical industry, drug testing, and medical applications.

In this work, we study the nanophotonics platform for plasmonic chiroptical sensing based on a thin gold film of 50-nm thickness on the quartz substrate. Exciting a surface plasmon-polariton via the prism coupling in the attenuated total internal reflection regime (Kretschmann configuration [3]) with a plane TM-polarized wave, we study the reflection spectra. In this case, the small response in the TE-polarization emerges due to the mixing of electric and magnetic fields. As a result, there is the angular shift between the spectral resonances in right- and left-handed circular polarized waves due to the presence of the chiral substance.

Then, we structured a thin film over a gold meta-grating to enhance the sensitivity of the chiroptical sensor. We observe the enhancement of the chiral sensitivity by about two orders of magnitude. The observed enhancement is explained by the appearance of Rayleigh’s anomaly [4], which arises due to the meta-grating’s structure. This phenomenon occurs under specific conditions where a diffracted wave originates and propagates under the grazing angles along the grating surface, becoming an evanescent wave. As a result, the coupling between the evanescent wave strongly localized at the edges of the grating and the chiral substance leads to enhanced light-matter interactions and significant amplification of the chiroptical response.

Thus, we demonstrate that the structuring of the thin plasmonic film leads to the multifold enhancement of the chiral sensing. Subwavelength plasmonic meta-gratings have strong prospects as a nanophotonics platform for detecting, quantifying, and separating low concentrations of chiral molecules. The results obtained open new opportunities for the optical sensing of polarization-sensitive molecules in the real-time regime.

[1] L. Warning et al., ACS Nano 10(15), 15538 (2021).
[2] S. Droulias, L. Bougas, ACS Photonics 6(6), 1485 (2019).
[3] E. Kretschmann, L. Raether, Z. Naturforsch. A 12(23), 2135 (1968).
[4] A. A. Maradudin et al., J. Opt. 18(2), 024004 (2016).

Primary authors: DEMIANYK, Oleh (V. N. Karazin Kharkiv National University); POLEVOY, Sergey (O. Ya. Usikov Institute for Radiophysics and Electronics NASU); TUZ, Vladimir (V. N. Karazin Kharkiv National University); YERMAKOV, Oleh (V. N. Karazin Kharkiv National University, Kharkiv, Ukraine / Leibniz Institute of Photonic Technology, Jena, Germany)

Presenter: DEMIANYK, Oleh (V. N. Karazin Kharkiv National University)

Session Classification: Quantum Technologies, Foundations and Optics

Track Classification: Quantum Technologies, Foundations and Optics