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Magnetoelectric fields: Probing the material chirality

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Probing the material chirality is of a fundamental interest in biology, chemistry, and metamaterial studies. The chiral asymmetry, in the rate of excitation of a small molecule, is proportional to the product of the chirality of the matter and the chirality of the electromagnetic (EM) field. Currently chiral plasmon polaritons draw much attention for creation twisted photons with enhanced chirality in the near fields. While, in optics, plasmon polaritons are coupled states of light with an electric dipole-carrying excitation, magnon polaritons in microwaves are coupled states of EM field with a magnetic dipole-carrying excitation. The measured forms of chiroptical intensity are inversely proportional to the wavelength of the probing radiation. That is why use of microwave radiation to detect chirality was considered as a non-solvable problem. During last several years, in the Microwave Magnetic Lab, BGU, we have been studing the effects of interaction of EM fields with magnetic-dipolar-mode (MDM) oscillations- chiral magnon polaritons observed in small ferrite disk particles. Our microwave-spectroscopy technique determines the rotational energy levels of chiral molecules with the aim to be applied for localized measuring of different biological liquids and biological tissue. Newly developed capabilities in microwave sensing using magnetoelectric (ME) probing fields originated from MDM resonators, provide a potential for unprecedented measurements of chemical and biological objects. ME fields are characterized by the helicity parameter which is a pseudoscalar. So the fields interacting with chiral molecules are distinguished by the same topological property. The shown ME-field sensing is addressed to microwave biomedical diagnostics and pathogen detection and to deepen our understanding of microwave-biosystem interactions. It can be also important for an analysis and design of microwave chiral metamaterials.

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Towards visible-spectral-range photocatalytic thin films

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Global demand for clean air and water is escalating and is a major challenge faced by contemporary society. Photocatalysis is a phenomenon that has great potential to address this challenge since it allows for conversion of photon energy into chemical energy. The most widely used photocatalytic material is titanium dioxide (TiO_2); however, it is limited to functioning exclusively in the ultra-violet range of the electromagnetic spectrum. In order to utilize solar radiation and increase the efficiency of photocatalytic devices, materials that exhibit photocatalytic activity in the visible spectra range are a prerequisite. High power impulse magnetron sputtering (HIPIMS) is a thin film deposition technique that provides a large flux of energetic film forming species and allows for a stable reactive deposition process. The dynamics of HIPIMS have been shown to facilitate efficient control of composition and structure in reactively grown metal oxide and oxynitride films. The present work aims at identifying the HIPIMS process conditions under which Ti-O-N films with photocatalytic activity in the visible spectral range are synthesized. The atomic composition and the crystal structure (i.e. attributes) of the Ti-O-N films employing reactive HIPIMS (in an Ar-O_2-N_2 atmosphere) are tuned for a wide range of deposition conditions with respect to the gas composition and the HIPIMS parameter space (e.g. pulsing frequency and pulse duration) and the relations between the above mentioned attributes and the photocatalytic behavior of the films are elucidated.

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