Ultra-broadband EPR spectroscopy in materials research

Valentyn Laguta[1], Maksym Buryi[1], Oleksii Laguta[2], Petr Neugebauer[2], and Martin Nikl[1]

[1]*Institute of Physics AS CR, Cukrovarnicka 10, Prague, Czech Republic*
[2]*Brno University of Technology, Central European Institute of Technology, Purkyňova 656/123 61200 Brno, Czech Republic*

Electron paramagnetic resonance (EPR) spectroscopy is a very powerful tool for investigation of a variety of materials that contain unpaired electrons. It is thus important in branches of physics, chemistry and biology or medicine. It is sensitive to the static electronic properties of paramagnetic system as well as to ionic or molecular dynamics. EPR spectroscopy is also widely used in study of lattice defects created by light and ionizing irradiation. Commercial EPR spectrometers are typically operated at fixed microwave (MW) frequencies of 10 and 34 GHz and a magnetic field of 0 - 1.4 T. However, higher MW frequencies and fields (HFEPR) lead to drastic increases of the absolute sensitivity as a result of the larger MW quantum energy. Furthermore, the advantages of HFEPR also lie in the delivery of much higher spectral resolution, which allows precise determination of the electronic and geometric structures of lattice defects and local properties of materials. Today, HFEPR spectrometers become widespread in scientific research due to commercial availability of MW sources up to THz region and cryomagnets with fields up to 25 T, allowing quite simple construction of laboratory setups.

In this our report, we review our results recently obtained in investigation of optically active impurity ions in wide bandgap oxide materials used as a scintillators in detection of ionizing irradiation by applying the HFEPR technique at frequencies 100-1000 GHz. The advantages of HFEPR will also be shortly demonstrated in studies of other functional materials with magnetic and ferroelectric properties.

This work was supported by the GA CR under project No. 20-12885S and European Research Council under the ERC Starting grant AN714850