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# X-RAY AS A METHOD FOR MANIPULATION OF COLOR CENTERS CHARGE STATE IN DIAMONDS*

*E.S. SEKTAROV[1, 2], V.S. SEDOV[3], K.N. BOLDYREV[1]*

*[1]Institute of spectroscopy, Russian Academy of Sciences, Troitsk, Moscow, Russia*
*[2]Department of Physics, National Research University Higher School of Economics, Moscow, Russia*
*[3]Prokhorov General Physics Institute, Russian Academy of Sciences, Moscow, Russia*

Crystals with color centers are widely used in various fields of industry and science. They can be applied to optical quantum memory, quantum sensorics and quantum cryptography. Color centers are a defect in the crystal lattice that absorbs and/or radiates in the wavelength range outside the intrinsic absorption of the crystal.

In this work, we studied the charge states changing of color centers in diamond, such as nitrogen (NV), silicon (SiV), germanium-vacancy (GeV) centers, after their irradiation with X-rays.

The study of color centers in the X-rays was carried out on a Bruker IFS 125HR high-resolution Fourier spectrometer with a cryogenic attachment based on an X-ray tube BSV-30 with a copper anode, with a nominal power of 500 W and a characteristic radiation Cu Kα 8027 eV. The results of the research were absorption spectra obtained at a temperature of 5 K. The absorption method is a well-resolved structure of lines in the spectra, which makes it possible to quantify the concentration of color centers.

The obtained spectra illustrate that after X-ray exposure, the absorption line intensities change at wavelengths of 946 nm ($SiV^0$), 737 nm ($SiV^-$), 575 nm ($NV^0$), 637 nm ($NV^-$) and 602 nm ($GeV^-$), corresponding to color centers. In the sample with GeV, the appearance of new lines was observed, which can relate to $GeV^0$ and/or $GeV^+$ centers. A change in the SiV and NV centers was noted, the increase in the concentration of $SiV^0$ is proportional to the decrease in $SiV^-$. A more complex interaction is observed between $NV^0$ and $NV^-$ because other charge states such as $NV^+$, $NV^{2+}$ or unknown states may be involved in the process as the appearance of new lines after irradiation was found.

For samples with NV and SiV, changes in defect concentrations (x) were calculated using formula (1) from [1]. Calibration coefficients $k_{zpl}$ are given in [1] for SiV and [2] for NV, the integral intensity $I_{zpl}$ of absorption lines was calculated using the OPUS software.

$$I_{zpl} = k_{zpl} \cdot x\,, \tag{1}$$

The result of research demonstrates that X-rays radiation can control the charge states of color centers in diamonds.

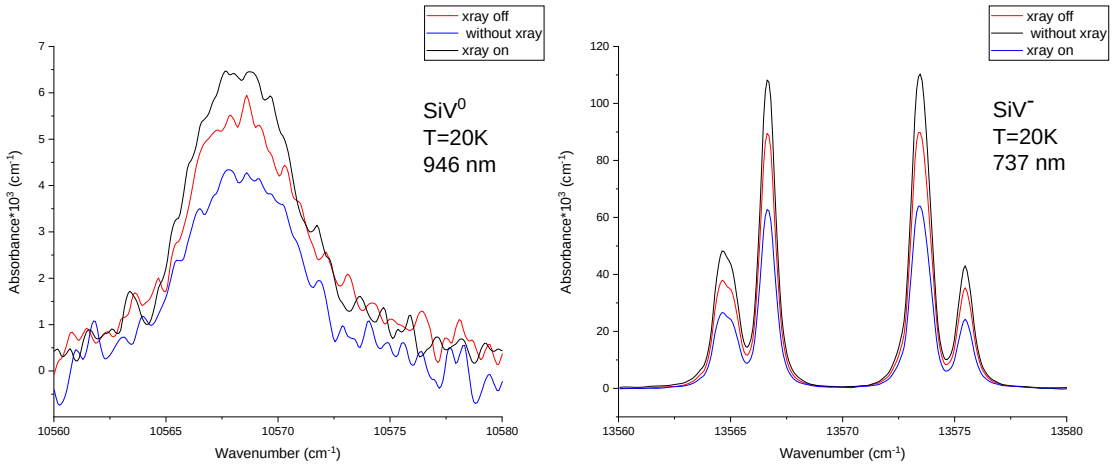


Fig.1. The changing of $SiV^0$ and $SiV^-$ absorption spectra by X-Ray radiation.

## REFERENCES

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