Change Of Cathodoluminescence Spectra Of HTHP Diamonds Irradiated By Electron Beam In Visible-UV Region

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Tomsk, 2020

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INTRODUCTION

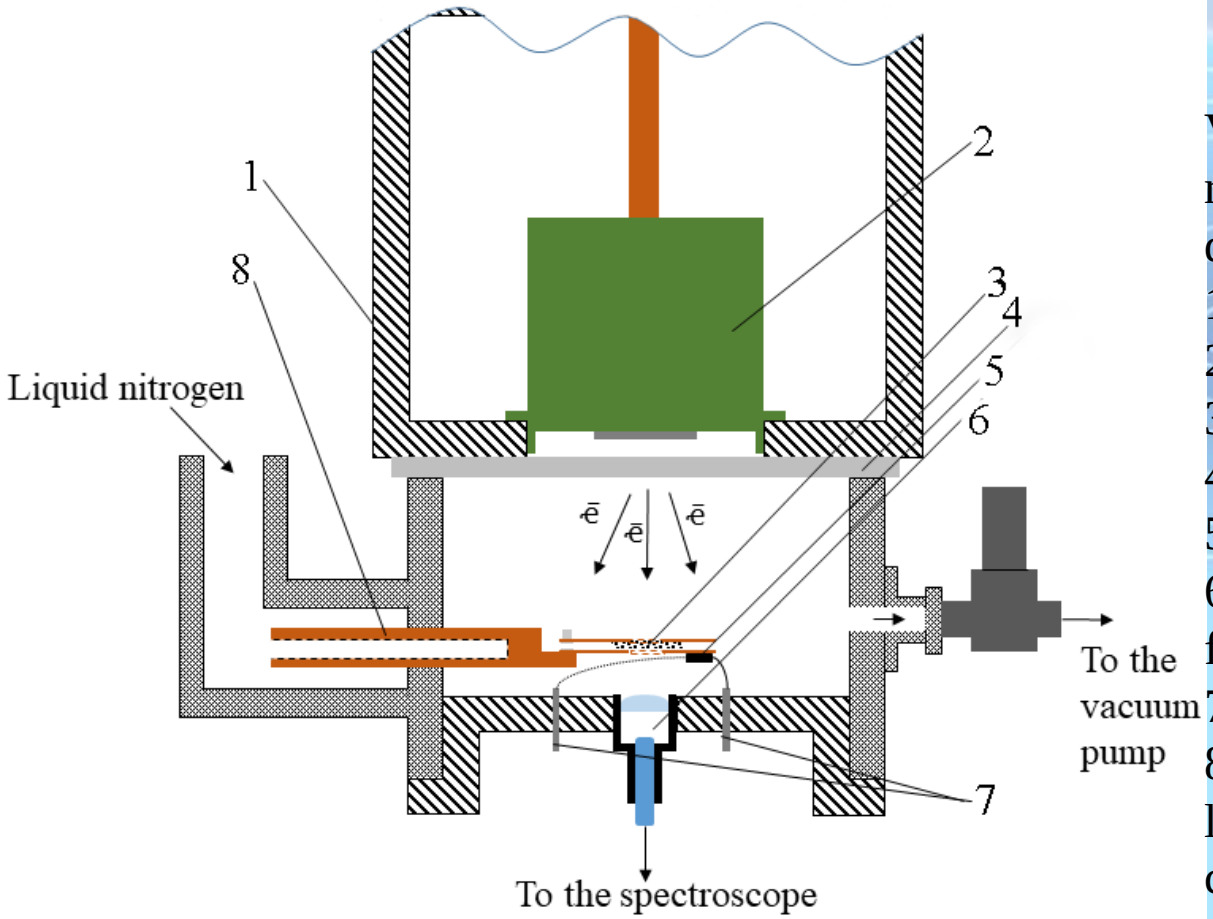
It is known, that nitrogen-vacancy (NV) centers in diamond are adjective single-photon emitters, with applications in quantum technologies.

Two charge states are known for N-V centers: N-V^0 and N-V^-, with the latter being mostly studied due to its long electron spin coherence time. NV centers in diamond are promising elements for quantum optical systems since they are single-photon emitters with high photo stability, quantum yield and brightness, even at room temperature. Typically, synthetically prepared diamonds with NV centers contain both N-V^0 and N-V^- states. Therefore, control of NV centers state in diamond is an important scientific problem.

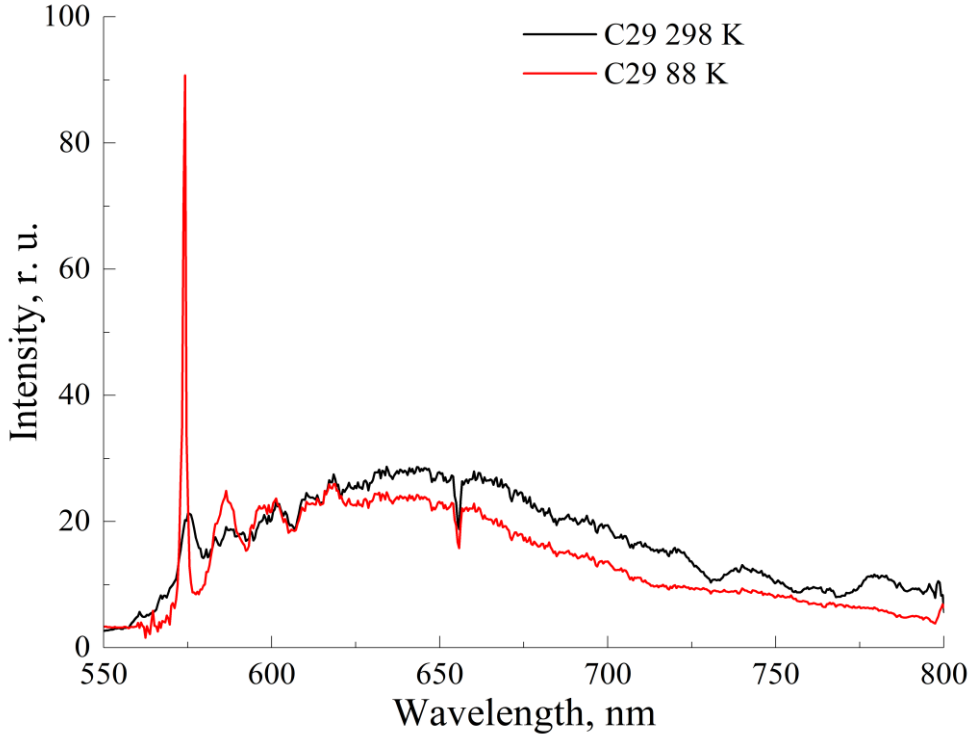
The technologies of diamond synthesis by the high-pressure high-temperature (HPHT) and chemical vapor deposition (CVD) methods are constantly improving. The HPHT method allows the production of bulk diamond samples with sizes up to 20 × 17 × 11 mm. The CVD method makes it possible to obtain diamond wafers up to 120 mm in diameter and 3 mm in thickness. Both of this synthesis processes are a good in creation of various type of vacancies in the diamonds bulk. And thus they are approaching for researches aimed to the study of various kinds of vacancies.

<u>The main goal of this work</u> - was to investigate the changes of optical spectra of cathodoluminescence of different specimens of diamonds and find a specimen with cathodoluminescence at the edge of fundamental absorption. We used five diamond samples, which was synthesized by high pressure and high temperature method (HPHT). For that samples we measured optical cathodoluminescence spectra in the range 200 – 1100 nm.

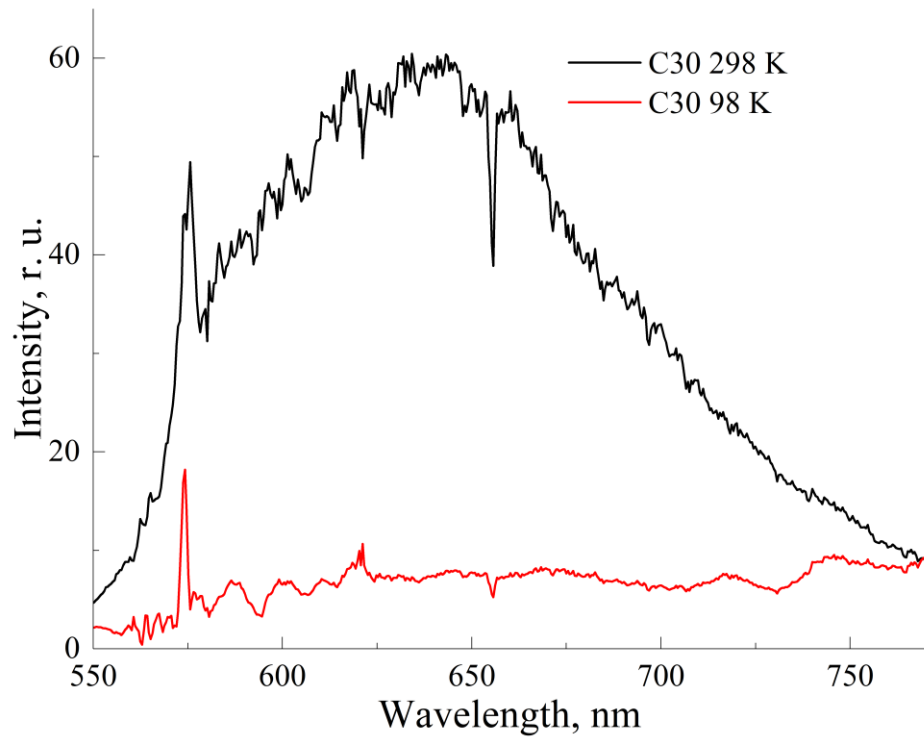
Experimental Setup



Vacuum electron beam system for research cathodoluminescence of dimonds:
1 – RADAN-220 body,
2 – vacuum electron tube,
3 – diamond specimens holder,
4 – 10 micron aluminium foil,
5 – termistor,
6 – optical collimator whith a fiber,
7 – contact pins,
8 – copper “finger”, filled by liquid nitrogen, for specimens chilling.

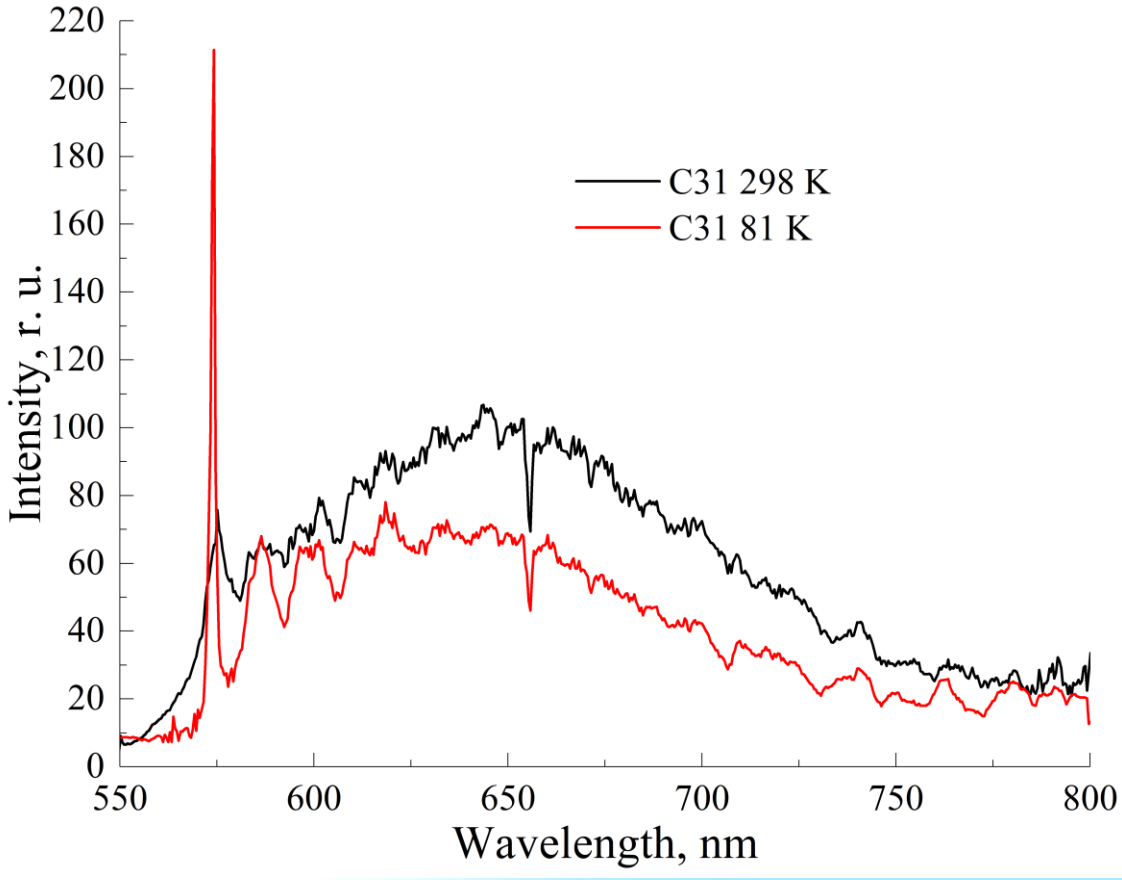


(a)



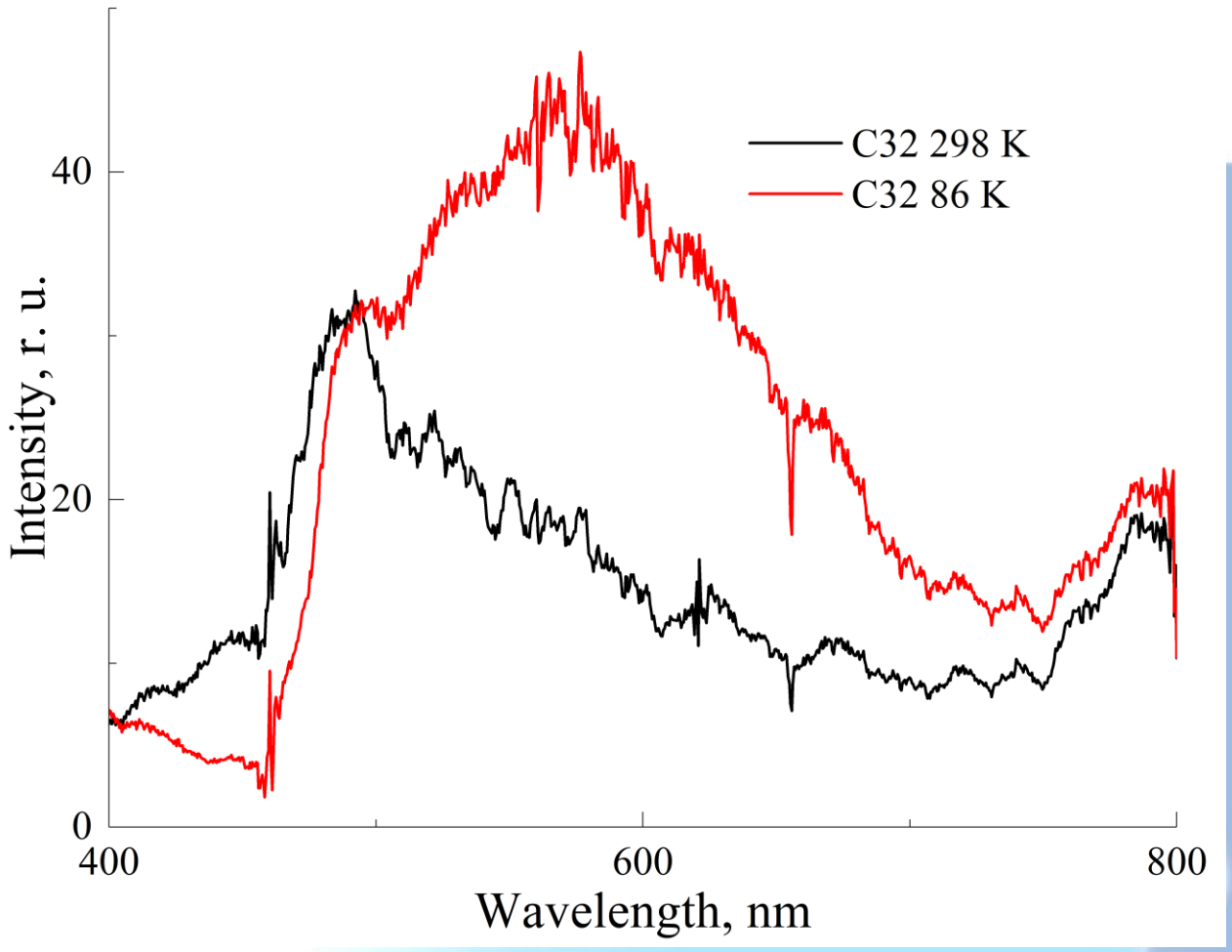
(b)

Comparison of cathodoluminescence spectra of C29 (a), C30 (b) and C31 (c) (next screen) specimens at the room and liquid nitrogen temperature.

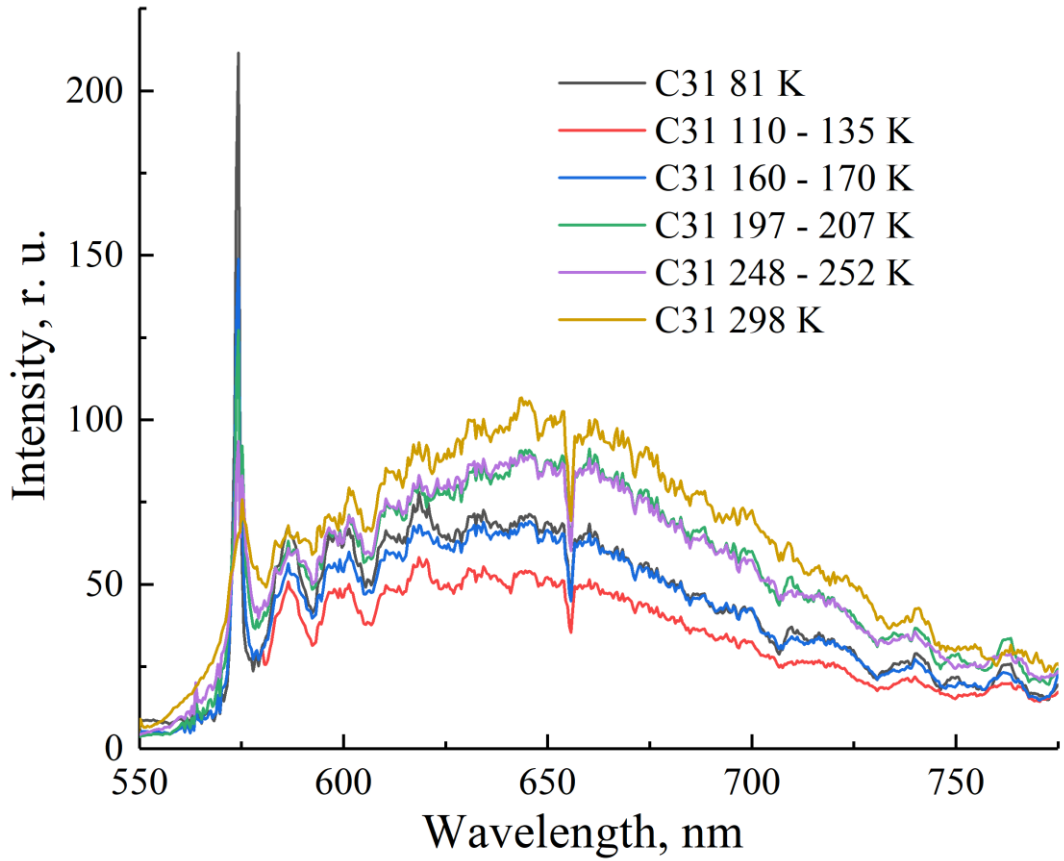


(c)

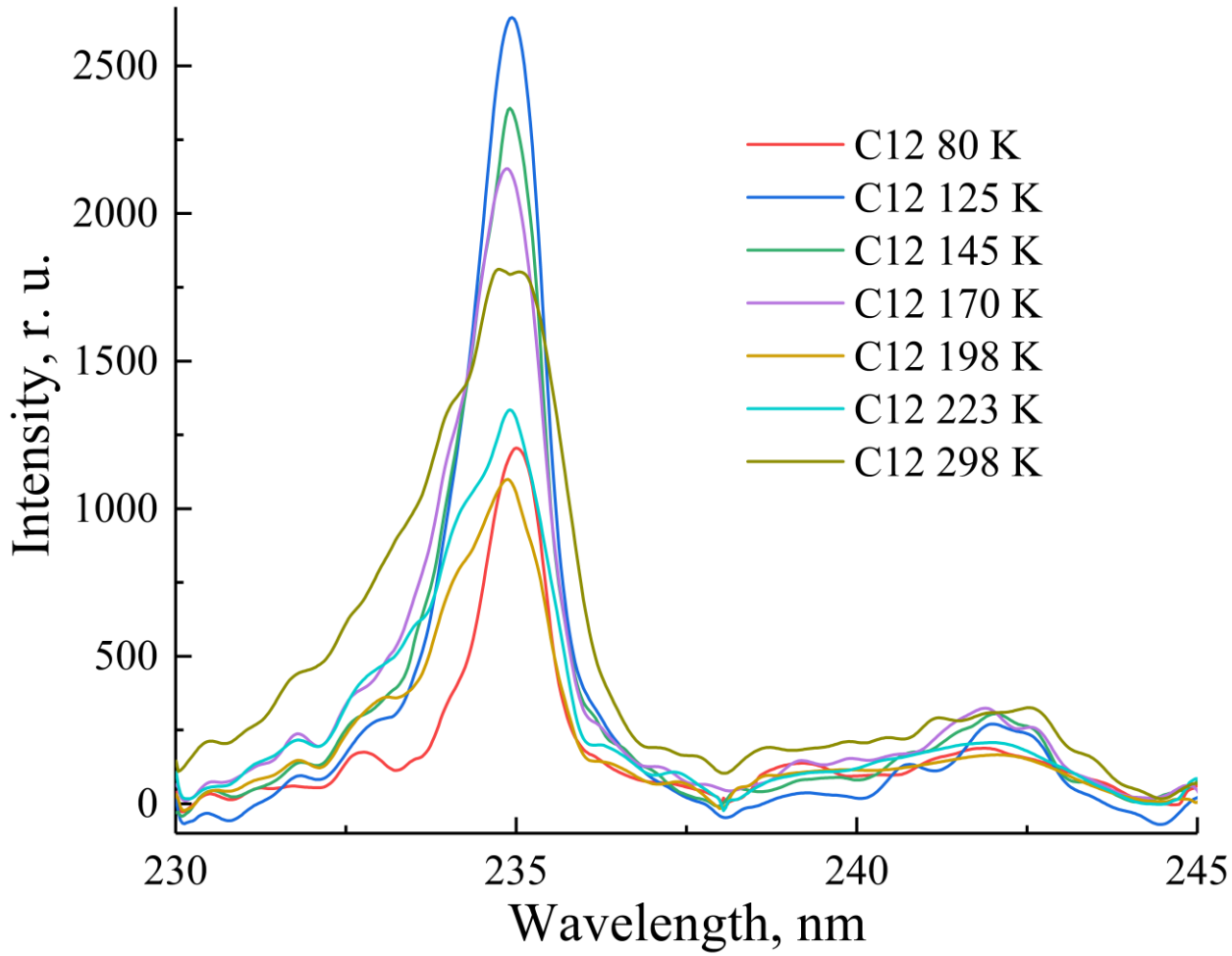
Comparison of cathodoluminescence spectra of C29 (a), C30 (b) (previous screen) and C31 (c) specimens at the room and liquid nitrogen temperature.



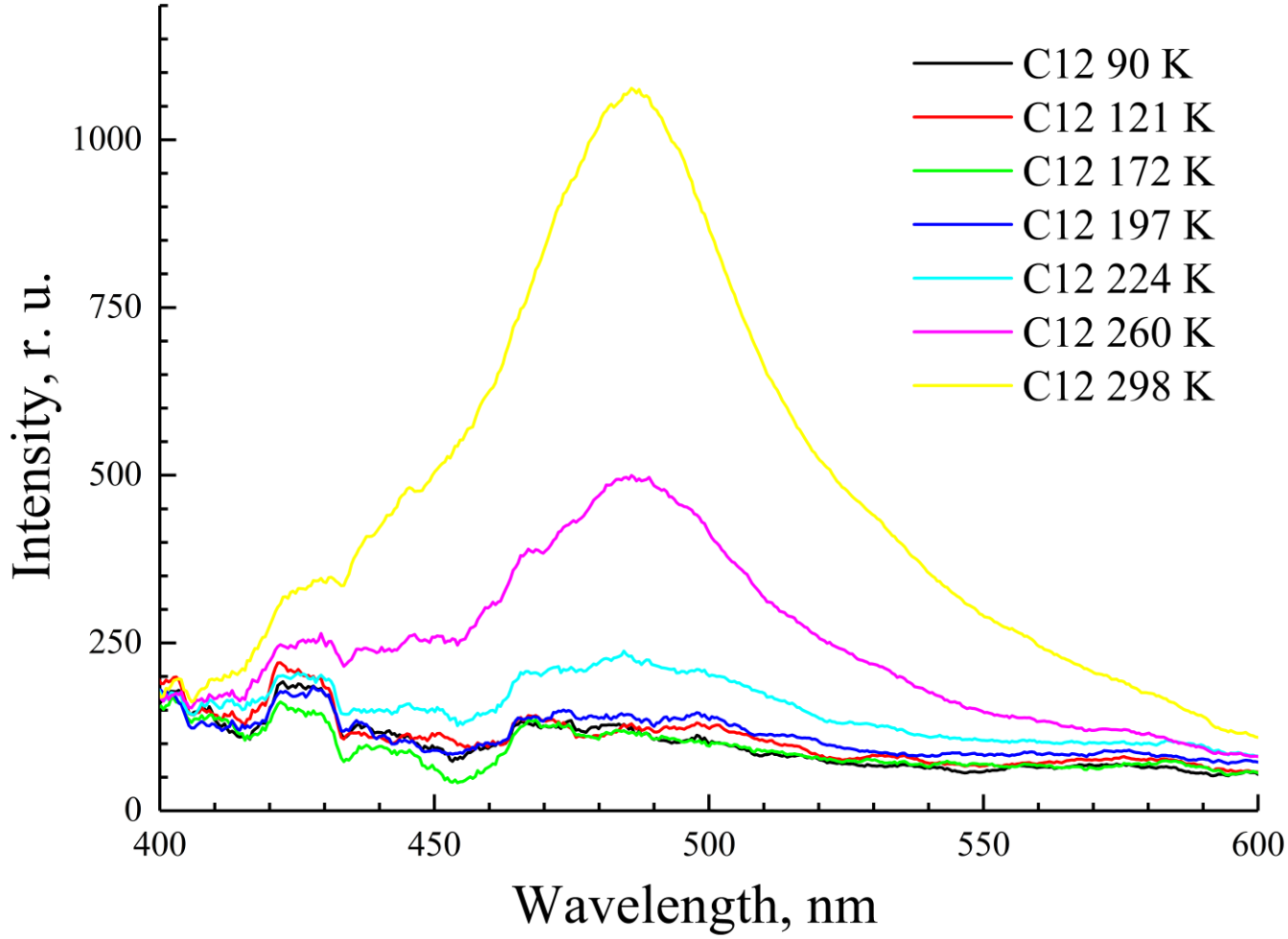
Comparison of cathodoluminescence spectrum of C32 specimen at the room and liquid nitrogen temperature.



Temperature dependence of cathodoluminescence intensity of C31 specimen from 81 K to 298 K.



Temperature dependence of cathodoluminescence intensity of C12 specimen in the UV region from 80 K to 298 K.



Temperature dependence of cathodoluminescence intensity of C12 specimen in the visible region from 90 K to 298 K.

Conclusion

- In our work we investigated the optical cathodoluminescence (in the range 200 – 1100 nm) of five HPHT synthesized diamond samples at the temperature range 80 – 300 K.
- C29, C30, C31 specimens showed an increasing of zero phonon line intensity at 575 nm with decreasing of specimen's temperature.
- Cathodoluminescence of C32 specimen has character other than for C29-C30 specimens, which requires further investigation.
- Single crystal C12 synthesized by the HPHT method exhibited a strong free excitons radiative recombination band at 235.2 nm and "freezing" of cathodoluminescence at 400 - 600 nm with temperature decreasing.
- Based on the obtained experimental data, we can conclude that C12 specimen could make a good challenger for cathodoluminescence source of UV radiation.

The work was carried out as part of the state task of the Ministry of Education and Science of Russia (# 0721-2020-0048).

THANK YOU FOR YOUR ATTENTION