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About type II diamonds showing a 648.0 nm PL peak

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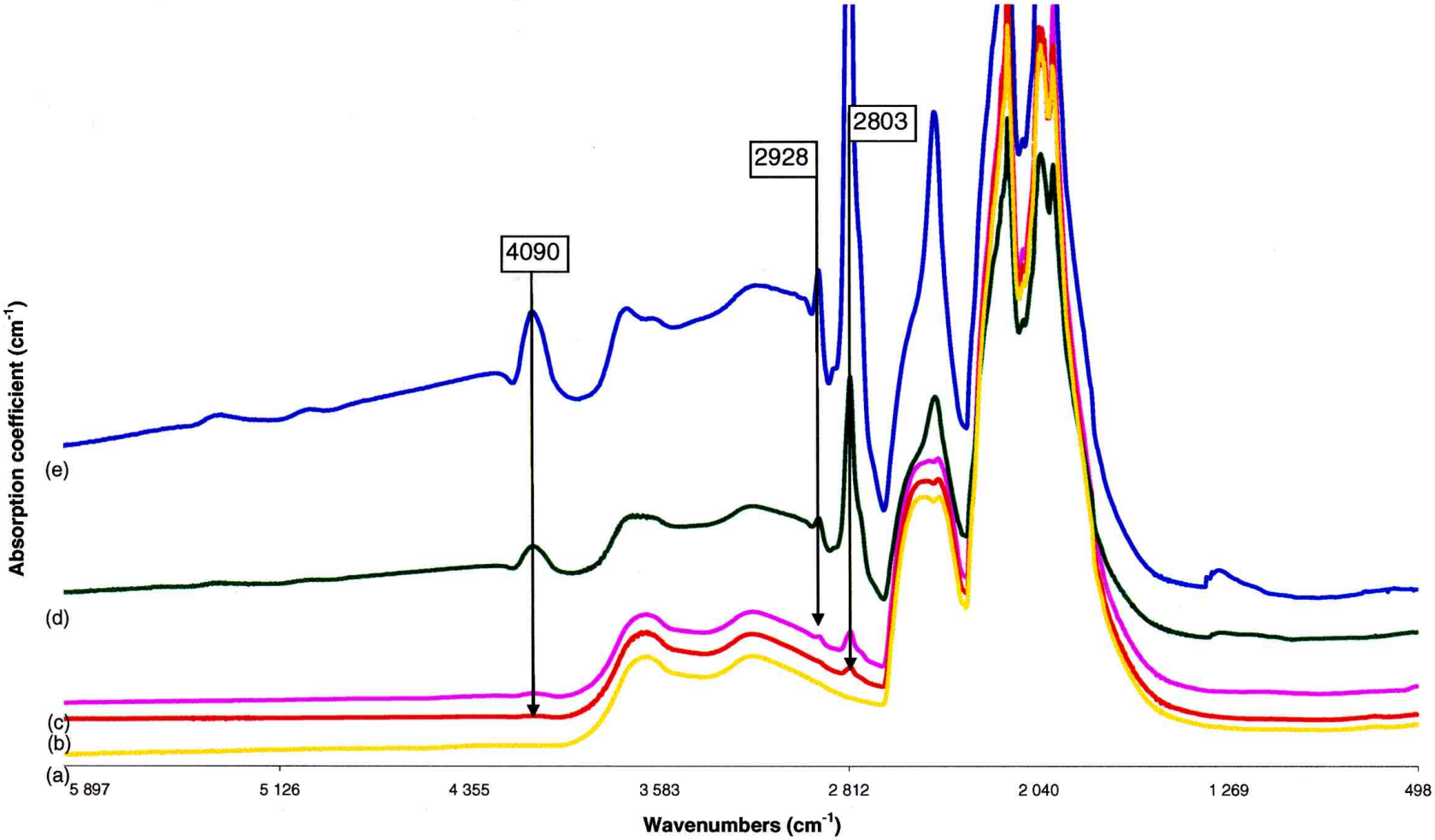
INTRODUCTION

The SSEF-Swiss Gemmological Institute studied thirteen untreated colourless diamonds of type II showing a rare and so far, not completely ascribed 648 nm Photoluminescence (PL) peak.
The weight of the studied diamonds range from 1.00 ct to 16.31 ct. On the GIA colour grading scale, their colour range from D to light blue and to fancy greyish blue.
The PL spectra were recorded on our Raman Renishaw 1000 system using a green ionised Argon Laser emitting at 514.5 nm.
Complementary study shows that six of the thirteen studied diamonds share common infrared absorption.

INFRARED

Two of these diamonds show a typical boron absorption band and are classified type IIb diamonds. For four other diamonds, we observed infrared absorption features at 2803, 2928 and 4090 cm^{-1}. This strongly supports the presence of a slight concentration of boron, because the three absorptions features superimposed onto the intrinsic absorption of type IIa diamonds are those of the typical absorption of type IIb diamonds. For these four diamonds, the concentration of boron is so slight that the typical absorption band of type IIb diamonds (between 1100 and 1331 cm^{-1}) is not detectable. Nevertheless it modifies the intrinsic absorption region of their infrared spectrum. Thus, among the thirteen studied diamonds, boron is detected in six samples by infrared spectroscopy.
The relation between the 648.0 nm PL and the presence of boron is described by Charles (Charles et al., 2002). Therefore, we assume that the thirteen studied diamonds contain boron, even though for seven of them its concentration is so slight that it does not affect the infrared absorption spectrum.



The infrared spectrum of a type IIa diamond (a) is compared with 4 infrared spectra of type IIb diamonds of increasing boron concentrations [from (b) to (e)].
Spectra (e) and (d) are those of typical type IIb diamonds showing the well known absorption band between 1100 and 1331 cm^{-1}.
Spectra (c) and (b) only show slight absorptions at 2803, 2928 and 4090 cm^{-1} due to the typical electrical field created by the presence of boron.

MEASURED STRESS

It is known that boron impurities induce stress in the lattice of diamond (Anthony, 2005). In order to evaluate the stress of the studied diamonds, we have measured the Full Width at Half Maximum (FWHM) of their GR1 PL line. We found five values well above 1.20 meV, the highest value reaching 2.91 meV. The lower value is 0.51 meV and surprisingly, the FWHM of the vacancy related peak of three colourless diamonds of a D colour on the GIA colour grading scale, range between 1.34 and 2.50 meV. In our experience and considering our instrument set up, 1.20 meV is the highest value for colourless diamonds of type IIa which do not show the 648 nm PL peak. It is noticed that strain induced by plastic deformations also provoke a noticeable stress.

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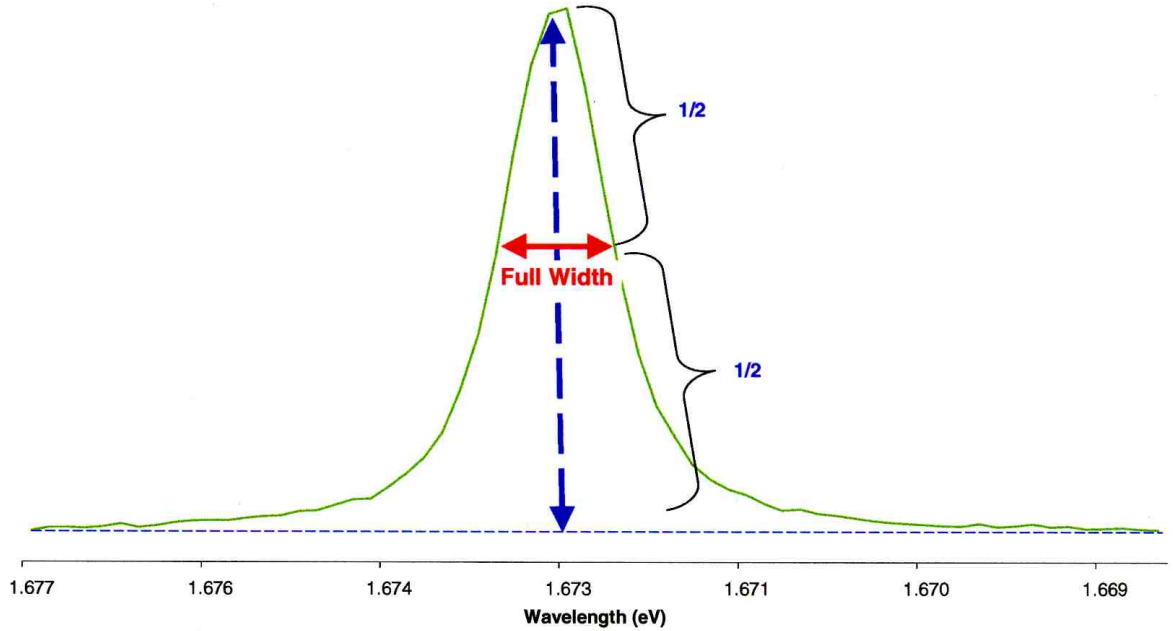

For this study, the stress of a diamond is expressed by the Full Width at Half Maximum (FWHM) of the GR1 PL peak at 1.673 eV.
The FWHM is the measurement of the width of the peak (in meV) at the half high of the peak.
The FWHM of the GR1 photoluminescence peak ranges from 0.51 to 1.20 meV for most of type IIa diamonds of a D colour.
For a few of these diamonds the value may exceptionally be higher (i.e. from 1.34 to 2.50 meV). These exceptionally high values are explained by the fact that the diamonds show a 648 nm PL peak related to a very slight boron concentration which together with a possible strain induces an unusually high stress.

CONCLUSION

We have shown that diamonds of natural coloration showing a 648.0 nm PL peak may have a FWHM photoluminescence vacancy related line well above 1.20 meV even though they are of a D colour.

ACKNOWLEDGMENTS

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REFERENCES

T. R. Anthony (1995) Stresses generated by impurities in diamond, Diamond & Related Materials, Vol.4, No.12, pp. 1346-1352

S. J. Charles, J. W. Steeds, D. J. F. Evans, S. Lawson and J. E. Butler (2002) Characterisation of electron irradiated boron-doped diamond, Diamond & Related Materials, Vol. 11, No. 3-6, pp. 681-685