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THE WIDTH OF THE 1332 cm^{-1} RAMAN LINE IN DIAMOND

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ABSTRACT

The width of the 1332 cm^{-1} Raman line in diamond has been measured using 6328 Å He-Ne laser excitation and a double grating monochromator for analyzing the scattered light. The Raman and system line profiles were determined for various settings of the spectrograph entrance and intermediate slits. The Raman line width was determined for each setting using the method employed by Park [Phys. Letters, 22, 39 (1966)]. The average of the various determinations is $\Delta\nu = 1.88 \pm 0.12$ cm^{-1} FWHM.

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In calculations of the stimulated Raman emission gain in diamond the width of the 1332 cm^{-1} line is often assumed to be approximately 1 cm^{-1}.[1] In this paper we report the result of a measurement of this linewidth.

A Spectra Physics Model 125 He-Ne laser operated at 6328 Å was used for excitation. All measurements were performed at room temperature. The specimen investigated was a single crystal about 3x3x3 mm in size. The crystal was suspended free of any strains. The laser beam was focused into the crystal with a microscope objective, whose focal point was imaged onto the entrance slit of the spectrograph with a high aperture projection lens. The scattered light was analyzed with a Spex 1400 double monochromator with photon counting equipment. The pulses were amplified and stored in a multichannel analyzer operated in the multi-scaling mode.

To determine the linewidth the Raman line profile was determined for various settings of the spectrograph slits. The exit slit was kept constant at 1 mm width, while the entrance and intermediate slits were set at various equal values between 9 and 59 μ. The height of the entrance slit was kept at 2 mm to ensure good resolution. Keeping the exit slit very wide greatly aided in avoiding tracking errors at small slit widths. In addition to the Raman line profile, the system line profile (i.e. the laser line profile) was determined at each setting. Special care was taken to keep the pulse count rate within the linear region of the detection system. A spectrogram of the Raman line obtained with 39μ slits is shown in Fig. 1. This slit width corresponds to about 1 cm^{-1}.

From the line profiles the Raman linewidth was determined using the method employed by Park.[2] The result obtained was

$$\Delta\nu = 1.88 \pm 0.12 \text{ cm}^{-1} \text{ FWHM} \qquad (1)$$

The result is an average of the values obtained for different settings and the error is calculated directly from the spread in the individual results.

To assure the validity of this result, the measurements were repeated for different polarizations of the laser beam and different orientations of the crystal. In all cases the result fell within the experimental limits of error.

In conclusion it should be noted that the use of a digital memory for storing the output pulses from the photomultiplier tube greatly facilitates the analysis of the results. Any subjective errors of the kind encountered, e.g. in treating a recorder trace are completely eliminated. Also, very accurate determinations of line profiles are possible as both the system line profile and the Raman line profile are measurable with great accuracy.

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FIGURE CAPTION

Fig. 1 An original spectrogram of the 1332 cm^{-1} Raman line in diamond obtained with 39μ slits.

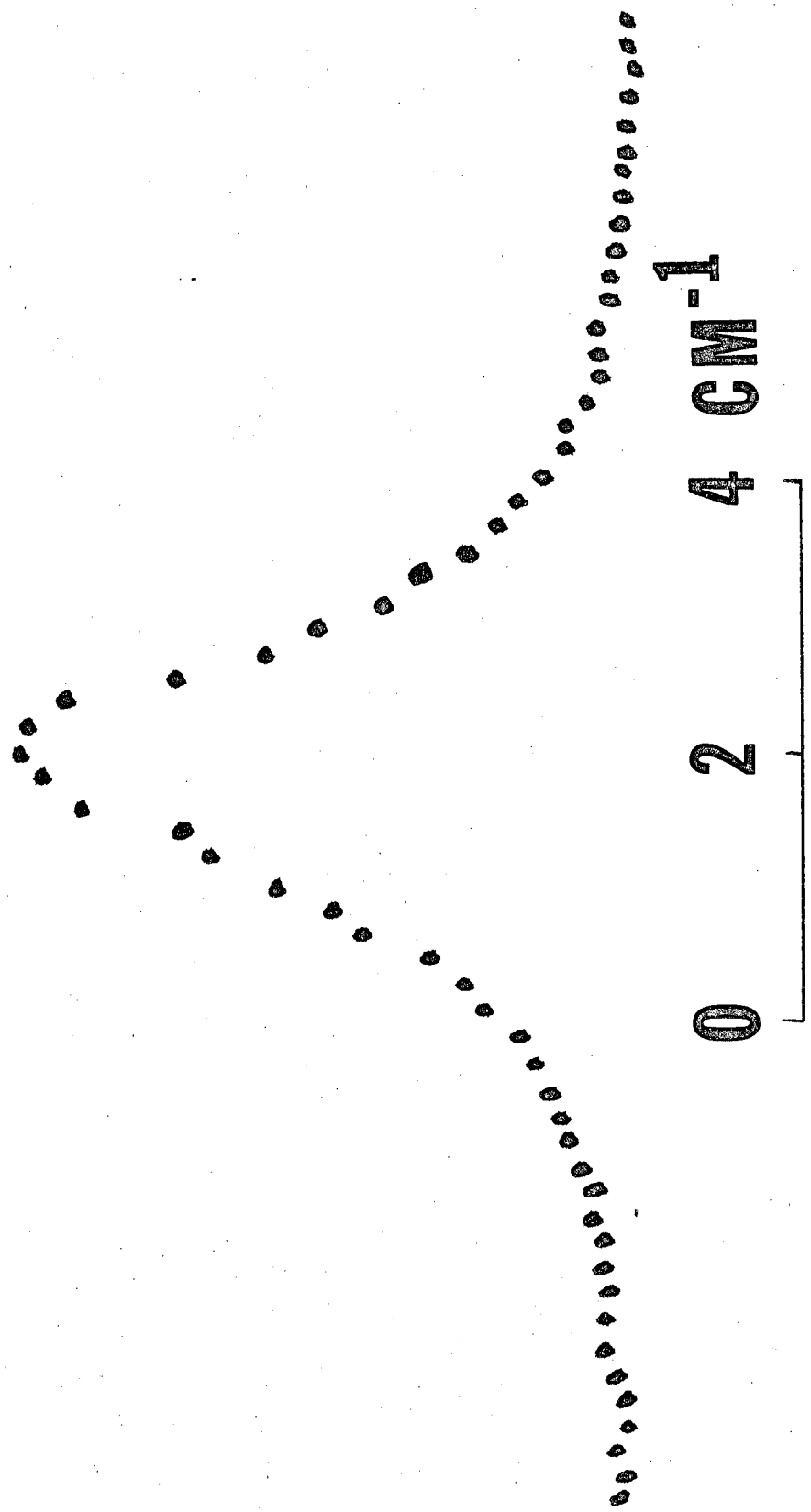

Fig. 1

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