OPTICAL MEASUREMENT SYSTEM FOR NON-CONTACT TEMPERATURE PROFILE

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INTRODUCTION

In principle all objects emit thermal radiation as a consequence of their temperature. The thermal radiation emitted by an object depends on its temperature, surface condition and thermal properties. A thermography camera senses the emission from object, converts into temperature and display thermal images. The thermography camera is defined as measuring instrument used for non-contact measurements of the surface temperature of objects. The thermography camera generate thermal image of an object being viewed by converting radiant heat energy from the object into a signal that can be display on a monitor. The radiant heat emitted from the object is directly proportional to its temperature. Thermal image come into view as zones of different colours or shades depending upon the temperature range and mean temperature selected. The bright regions in the thermal image indicate high temperatures and the dark regions indicate low temperatures. In this study we make use of laser heating of High Temperature High Pressure (HTHP) industrial diamond, as well as the optically measured temperature profile of the HTHP industrial diamond surface. A XenCls thermography camera was used to measure the temperature profile of the sample (HTHP industrial diamond).

EXPERIMENTAL SET-UP

The experimental system for delivery of the laser beam is shown in figure 1. A continuous wave (cw) CO_2 laser was used in the experiment (Edinburgh instrument, model PL6). A Helium Neon laser was aligned to be co-linear with the CO_2 beam to facilitate alignment of the invisible infrared CO_2 beam throughout the optical system. A spatial filter was used to remove unwanted fluctuations in the intensity of the laser beam. A focusing lens, 250 mm was used to focus the laser beam to a sample. The sample was heated with the Gaussian beam profile and the temperature profile across the sample was measured using the XenCls thermography camera.

RESULTS

Figure 2 is the experimental data of the laser beam width against distance and the attached graphs are Gaussian intensity profiles. The Gaussian intensity profile enables one to determine the beam width. Figure 2 again indicates the temperature versus the distance of the beam width. Varying the beam width will also vary the temperature. Table 1 indicates the changes of a thermographs images of the hot industrial diamond as moving the sample in and out of the focal region of the beam, thus varying the temperature. Figure 3 are the surface temperature profile data that were measured using the XenCls thermography camera. USB 2000 and NIR 256 spectrometers were used to measured average temperature as shown in figure 4 Theoretical model graphs are show in figure 5. The theoretical curves show the surface temperature profile across the sample, peak temperature and average temperature, respectively.

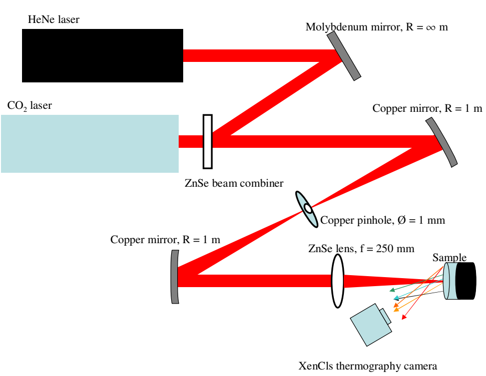


Figure 1: A schematic diagram of the laser beam delivery system for heating the sample and measuring temperature.

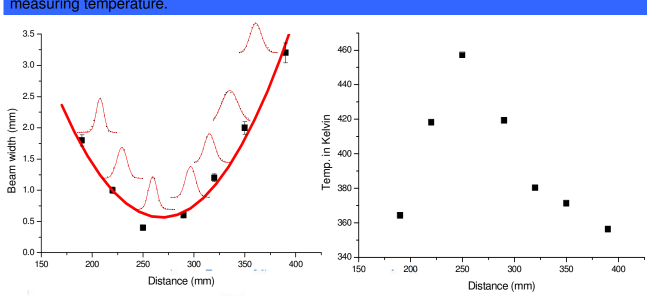
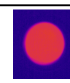
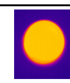
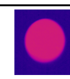


Figure 2: The beam size on the sample could be changed by moving the sample in and out of the focal region of the beam, thus varying the temperature of the sample.

Table 1: The thermographs images of the hot industrial diamond could be changed by moving the sample in and out of the focal region of the beam.

Pictures of hot industrial diamond			
Beam width	1.8 mm	0.6 mm	3.2 mm
Distance	190 mm	290 mm	390 mm

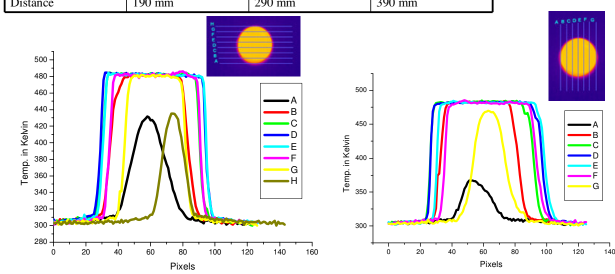


Figure 3: The temperature profile of the hot industrial diamond that was taken at the focal region of the beam. The temperature profile graphs show that the temperature increases very fast and became uniform across the centre of the sample and also fall-out the edge.

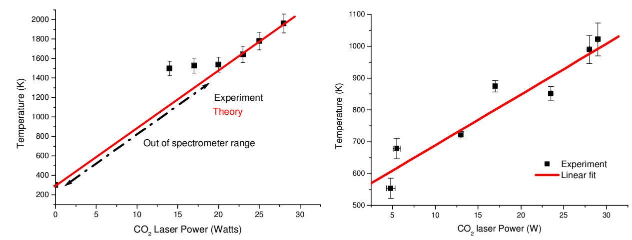


Figure 4: Plots of stabilised temperature versus power on the industrial diamond, showing the experimental and theoretical data/linear fit. These measurements were taken with USB 2000 (wavelength 300 nm – 1000 nm) and NIR256 spectrometer (900 nm – 2500 nm), respectively.

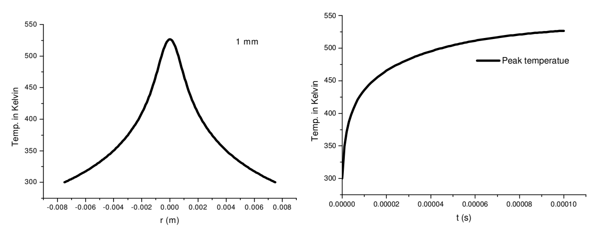


Figure 5: Theoretical graphs show the effect of laser beam size on surface temperature distribution and also the peak temperature rise in the micro-second scale.

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ACKNOWLEDGEMENT

We thank Bafana Moya and Corrie van der Westhuizen for their help in technical aspect of work.