Optical inscription of waveguides in Porous silicon

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Aim

The aim of the experiment was to analyse the effect of using an ultra-fast carbon dioxide laser. This created nano-sized features on porous-silicon chips that can be implemented to make optical waveguides.

Introduction

- Waveguides are a device used for the propagation of electromagnetic waves. They can direct power to a precise point, can handle large amounts of power and function as a high-pass filter.
- Carbon dioxide lasers are the highest-power continuous wave lasers that are currently available.
- Continuous-wave operation of a laser means that the laser is continuously pumped and continuously emits light.

Creating Porous Silicon and Method

- Porous silicon chips were created by taking a silicon wafer and etching in HF-Ethanol solution (1:1 concentration) under a 5mA current and 10-minute etching time.
- The porous silicon chips were then submerged in water then ethanol and finally pentane for drying purposes.
- Lenses were affixed such that the laser beam was focused onto the surface of the chips. The porous silicon-chips were attached to a sample holder which was mounted on a motor that moved perpendicular to the incident carbon dioxide laser.
- After each etch the sample was moved by 1mm and the laser power was increased by 10%.

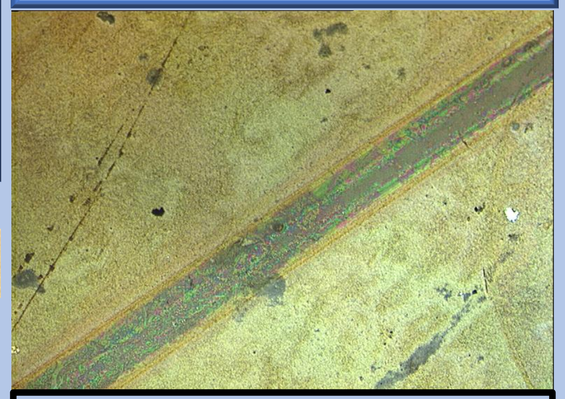

Figure I: Feature inscribed by laser etching the surface of porous silicon

Results

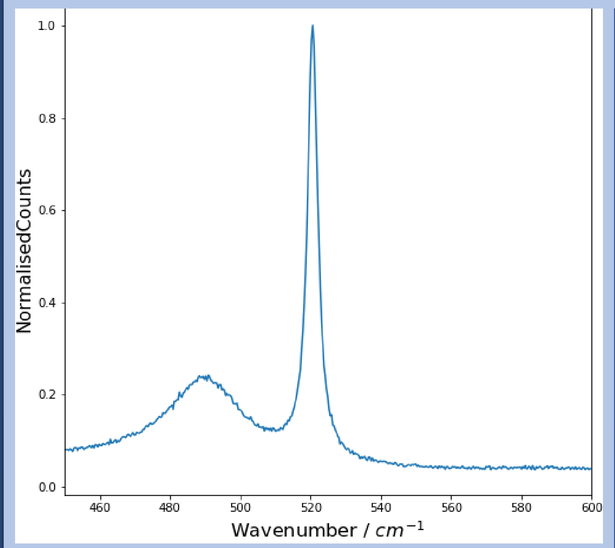

Figure II: Normalised Raman peak of porous layer

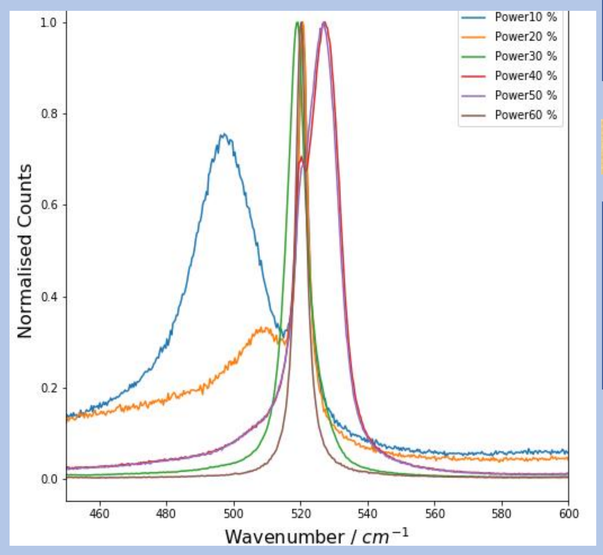

Figure III: Normalised Raman peaks of Laser etched surface

Conclusion

- The features created by the laser vary in structure depending on the power of the laser incident. The secondary peak located around 480 cm^{-1} becomes less pronounced with increased power.
- The changing of structure confirmed that the right amount of flux supplied to the surface allowed polymerization on the nanoscale.
- Initially, the technology will be used to create new photonic and opto-fluidic lab on a chip. These are devices with nanoscale features, but the tool will have many possibilities for other applications.

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