Raman and CARS Microspectroscopy

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Outline

- Raman spectroscopy
- CARS Function
- Conclusion

Raman Spectroscopy

Intro: What is Raman spectroscopy?

- Is a widely used **vibrational technique** which exposes a substance to some form of photons, and then by analysing the scattered photons we can gather information about the **properties of the molecule**.

- It's highly sensitive, high information content, non-destructive nature, and minimal/ no sample preparation.

- It's used across many fields of natural science which includes materials science, biology, chemistry, geology and many more.

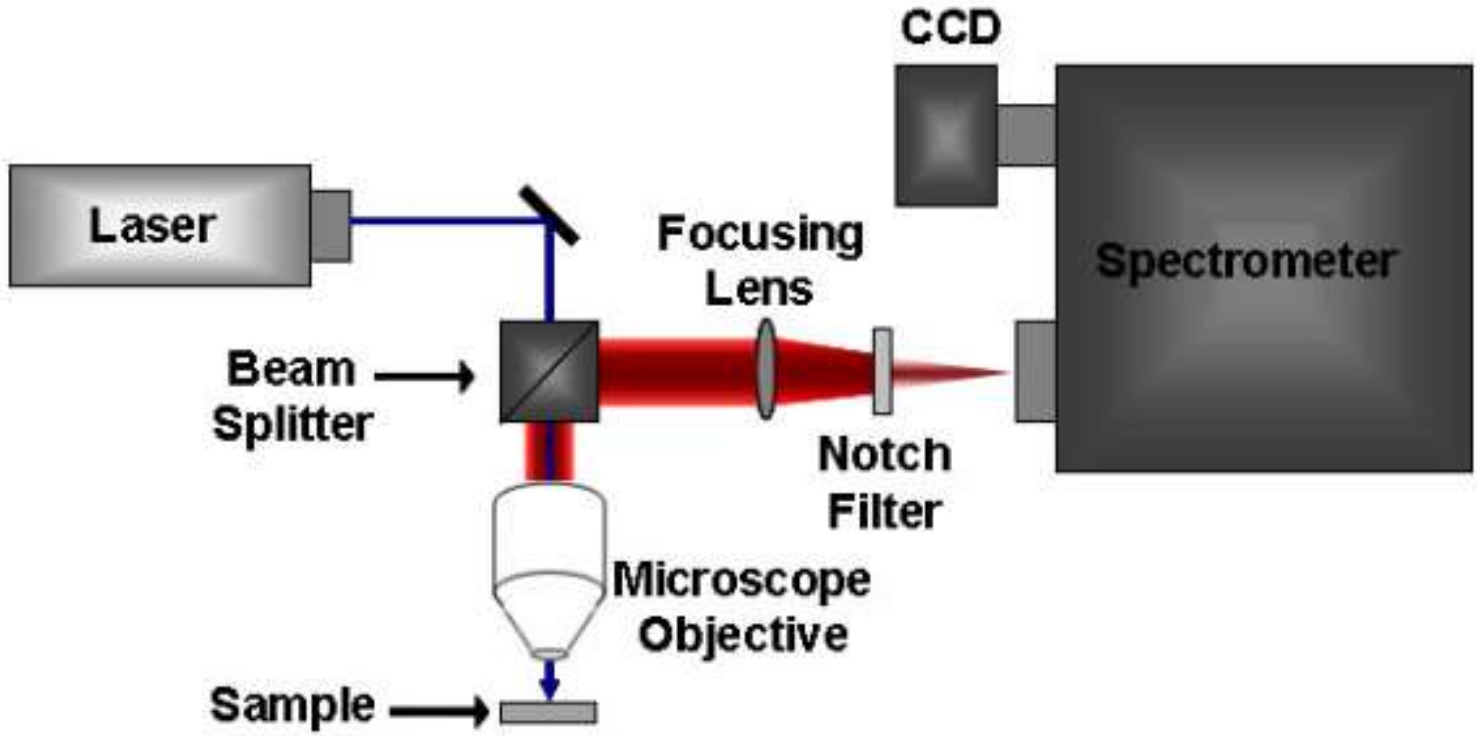


Fig.1. Schematic diagram showing the different components of a Raman instrument.

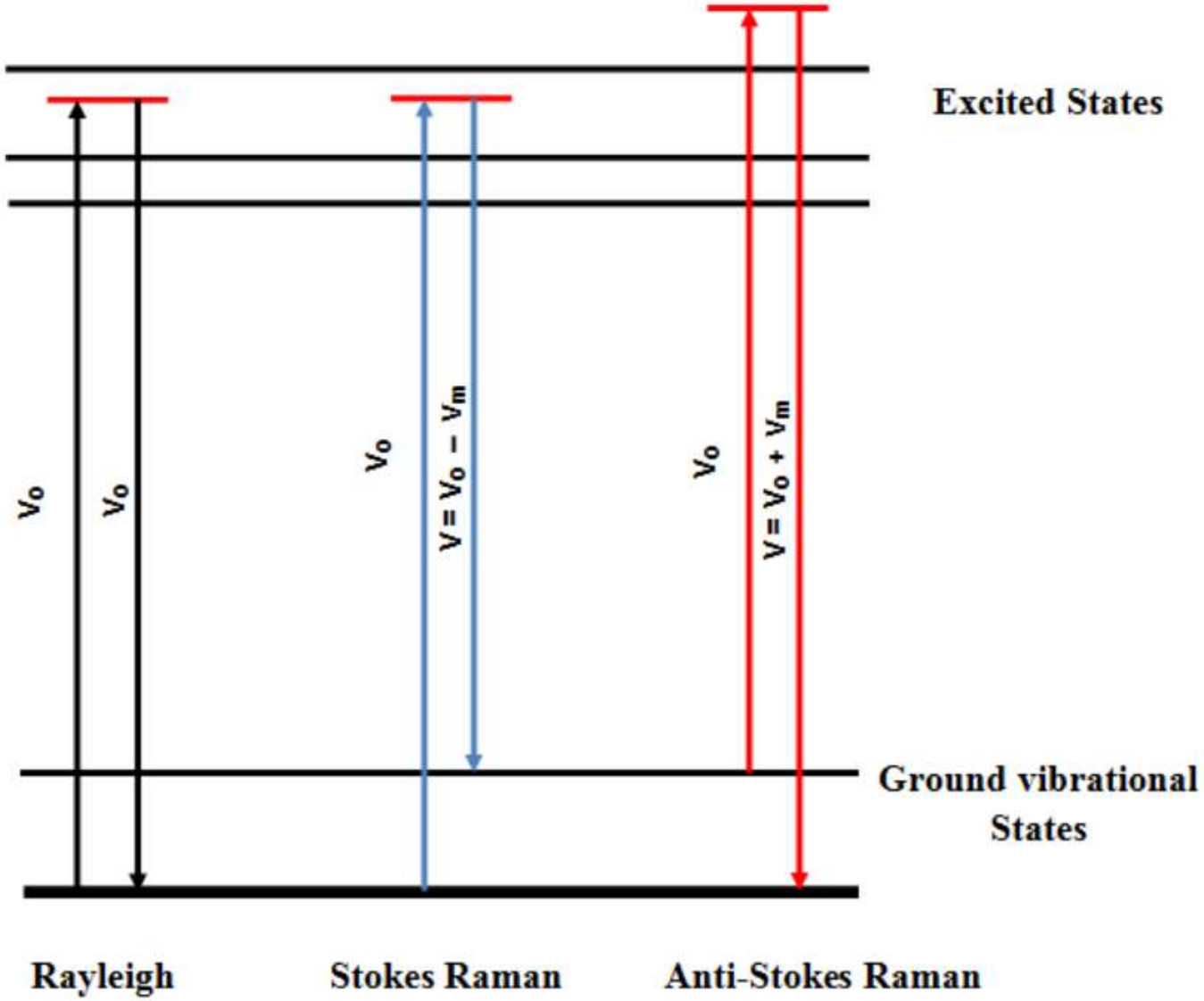


Fig.2. Three different forms of laser scattering.

Objective(s), work description and results

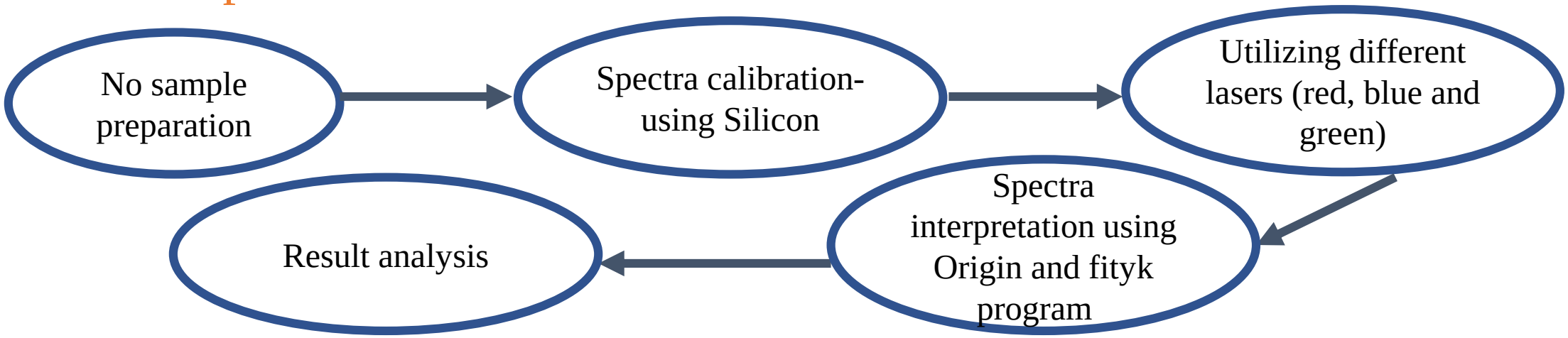
Objective(s)

- To study the effect of SHI irradiation and heat treatment on the microstructural changes of Se implanted polycrystalline SiC.

Practical application of SiC

- SiC is used as a main diffusion barrier of many radiological important fission products in the triple coated isotropic (TRISO) fuel particle.

Work description



Raman spectroscopy results

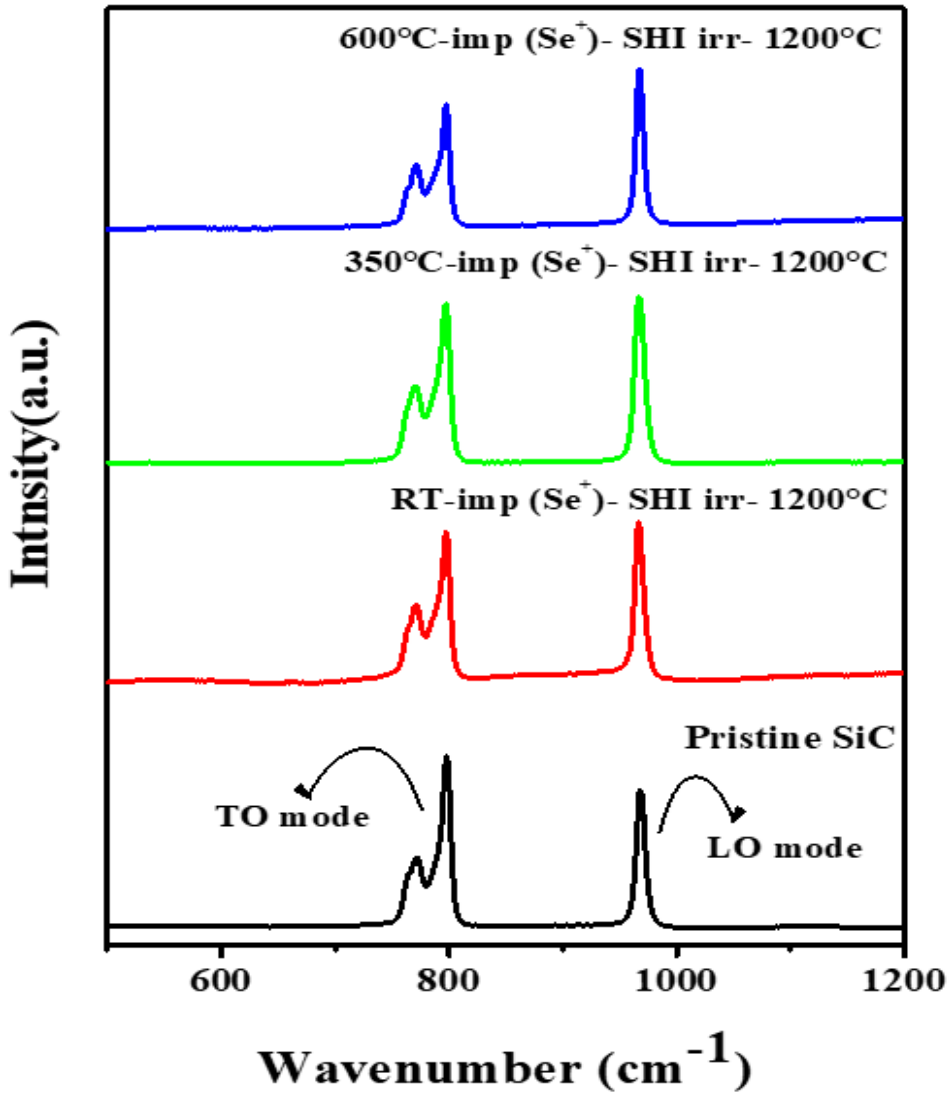


Fig.3. Raman spectra of pristine SiC, and RT, 350 °C and 600 °C implanted samples after SHI irradiation and annealing at 1200 °C.

Table. 1. FWHM and peak position of the LO mode for pristine SiC, and RT, 350 °C and 600 °C implanted samples after SHI irradiation and annealing at 1200 °C.

Sample ID	**FWHM**	**Peak position**
Pristine SiC	11.07	797.99
RT-imp (Se^{+}) - SHI irr-1200 °C	15.14	797.41
350 °C- imp (Se^{+}) - SHI irr-1200 °C	13.4	797.41
600 °C- imp (Se^{+}) - SHI irr-1200 °C	12.84	797.41

MR-150 Raman equipment

Fig.4. MR-150 Raman at the Department of Raman Spectroscopy, Frank Laboratory of Neutron Physics.

Coherent Anti-stokes Raman Spectroscopy (CARS)

- **What is CARS microspectroscopy ?**

➢ CARS involves a pump beam at a frequency ω_p and a Stokes beam at a frequency of ω_s. The signal at the anti-Stokes frequency of $\omega_{as} = 2\omega_p - \omega_s$ is generated in the phase-matching direction.

➢ CARS signals are stronger by 8-10 orders than normal Raman.

➢ Signals can be easily visualized.

➢ Scattering intensity is increased enormously and it reveals high resolution.

➢ Microquantities ($10^{-5} - 10^{-7}$) can be detected.

➢ CARS is excellent in the analyzing gaseous matter, biological samples, medicinal extracts etc.

Astaxanthin: A red pigment that belong to a group of chemicals called carotenoids.

Composition

- Astaxanthin, sorbitol (carrier), polyvinylpyrrolidone (binder), magnesium stearate (lubricant), colloidal silicon dioxide (anti-caking agent).

Benefits of Astaxanthin

- Astaxanthin is an antioxidant
- Protect cells from damage
- Improve the immune system functions

Results from CARS analysis technique

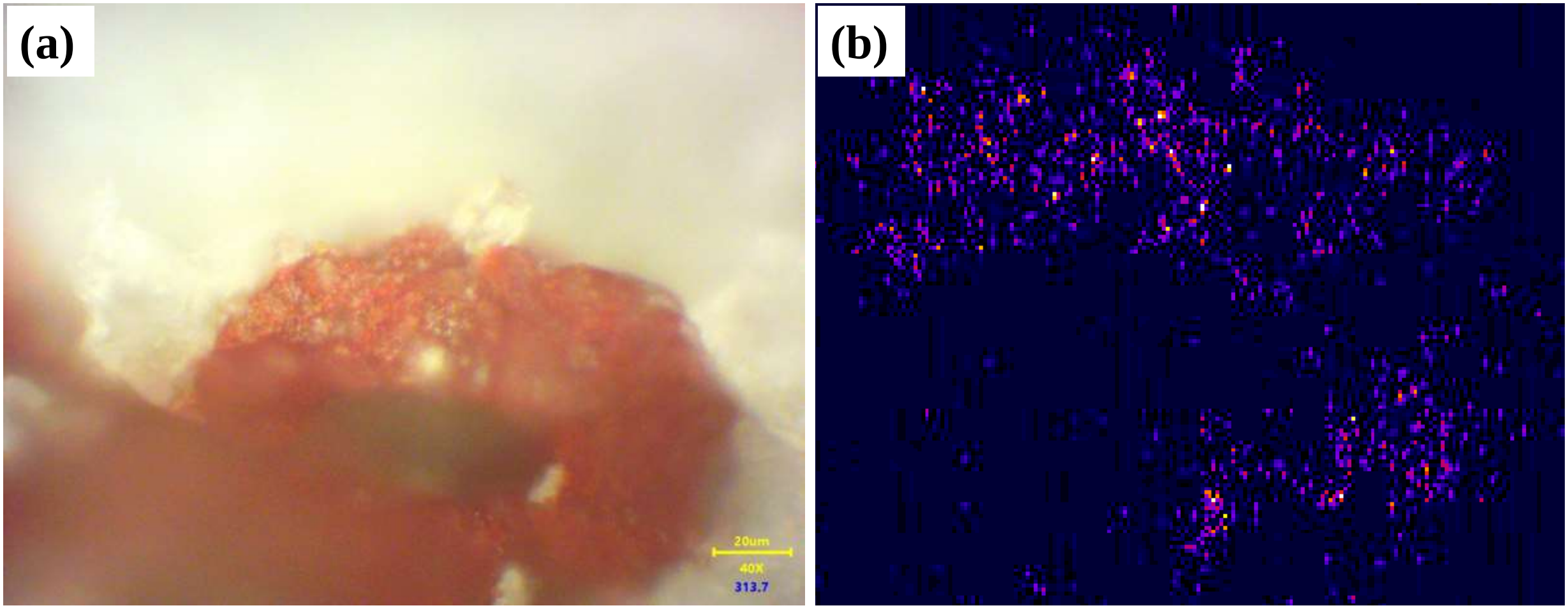


Fig.5. (a) sample image of Astaxanthin and (b) micrograph of Astaxanthin extracted from CARS microscopy.

Multimodal optical platform (CARS microscope) for performing transmitted light, Raman and CARS

Fig.6. Laser scanning confocal luminescence microscope (with CARS) at the Department of Raman Spectroscopy, Frank Laboratory of Neutron Physics.

Conclusion

- The hot (350 and 600 °C) implanted samples recrystallizes better than the RT implanted sample after SHI irradiation and heat treatment.

- SHI irradiation and annealing resulted in tensile stress within the subsurface of SiC substrate for all the implanted samples.

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