

We thank the reviewer for bringing up the important subject of SNR and the depth of focus. Our point by point response to the reviewer comments are following:

1. One of the major challenges in measuring Raman spectra of minerals is the positioning of the instrument for the efficient collection of Raman scattered photons. Is it possible for the authors to provide an analysis on the depth of focus of the system (i.e. SNR vs Working Distance) which could help the readers to understand the robustness as well as the flexibility of the system.

A. The optimum sample position with respect to the instrument is when the excitation laser is focused as perfectly as possible, on the sample, thereby generating the maximum amount of Raman signal. Raman signal generation is highly dependent on how tightly the excitation light is focused on the sample.

B. This means that if we utilize a focusing lens of higher NA (numerical aperture), we could obtain a stronger Raman signal because higher the NA, tighter (smaller) is the focused spot of the excitation light.

C. However, higher NA lenses are more difficult to focus because of their shorter working distances and very short depth of focus.

D. In our experiments, we utilized a 10x microscope objective lens that has NA of 0.25 and a 4x microscope objective lens that has NA of 0.1.

E. NA of 0.25 and 0.1 give us depth of field of approximately 8.5 and 53.2 micrometers, respectively. This could be computed using the approximate formula –

$$\text{Depth of field} \sim \lambda / N.A.^2$$

Raman signal will start to reduce rapidly if the sample is placed more than the depth of field distance away from the optimum focus.

F. Since SNR value would be dependent on the strength of the Raman signal, it is fair to assume that for the best SNR, the sample must be placed within the depth of field distance of the optimum focal spot of the excitation light.

A few other things, that are worth mentioning with respect to the SNR discussion is that SNR not only depends on the efficient focusing, but also on efficient collection of the Raman scattered signals (one has to match the NA of the input optics with the spectrometer collection optics in order to collect the maximum signal). In addition, the Raman signals depend very significantly on the nature of sample as well as the excitation wavelengths. Some samples, such as diamond and single crystal silicon give a very strong Raman signal, whereas other samples may produce relatively weaker signals.

In general, the Raman signals depend inversely to the fourth power of the excitation wavelength; thereby shorter wavelength excitation lasers generate stronger signals. Although practically, the fluorescence generated by the shorter

wavelengths outweigh the benefits (unless excitation is in deep ultraviolet wavelength, shorter than 250 nm).

In addition, by using an excitation wavelength closed to electronic transitions in a sample, may results in resonance enhancement of the Raman signals, which is typically 1-2 orders of magnitude. For example, blue/green laser light is typically used to enhance the Raman signals from carotenoid-containing compounds.

Noise performance of the detector is obviously another important consideration. With modern cellphone camera sensors having much better hardware (typically with back thinned and back illuminated cmos sensor chips) as well as efficient software algorithms to eliminate noise, which are further becoming better everyday, make the scientific uses of them very promising.

SNR related above discussion will be added to the revised manuscript.

2. One of the major challenges in measuring Raman spectra of minerals is the positioning of the instrument for the efficient collection of Raman scattered photons. Is it possible for the authors to provide an analysis on the depth of focus of the system (i.e. SNR vs Working Distance) which could help the readers to understand the robustness as well as the flexibility of the system.

With regards to environmental conditions, it is very important to eliminate any sunlight reaching the spectrometer. Traditionally this is achieved by having a hollow black color tubing between sample and the excitation laser lens with a small opening at the laser focus. The sample can then be placed directly at the laser focus against this opening eliminating the sunlight entering the spectrometer. Additional shielding from an opaque cloth can also be utilized.

Although not applicable for cellphone Raman spectrometer; it is possible to build solar blind Raman spectrometer with excitation in the deep ultraviolet wavelengths.

With regard to the day to day environment dust, it is not likely to effect the instrument performance by any significant amount. Typical working distance between the focusing lens to sample is 1-3 cm and scattering by dust in typical day to day environment would not reduce the laser excitation intensity at the sample by a significant amount. This discussion with respect to the environmental conditions will be added to the revised manuscript.

Sincerely,
Dinesh Dhankhar, Matthew Wehner