

## Laser alteration on minerals from hydrothermal and cold seep system by Raman spectroscopy

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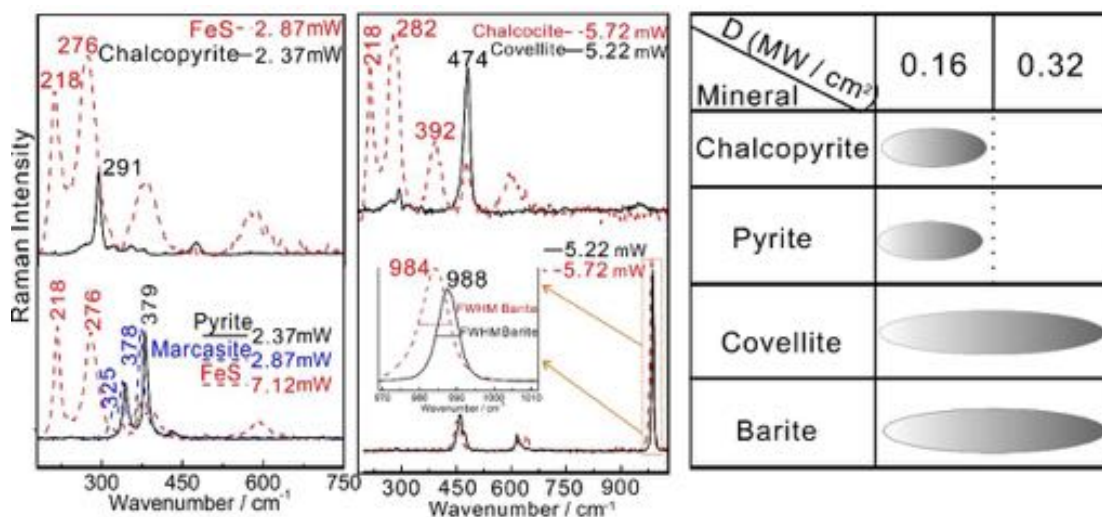
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### Abstract

Generally, Raman spectroscopy is a nondestructive technology for analyzing various samples<sup>[1,2]</sup>. However, a high laser power can cause alterations in some samples to a certain extent<sup>[3]</sup>. The study of minerals with respect to laser power is necessary for the precise identification of the minerals. Our results show that the heat induced by high laser power thermally oxidizes chalcopyrite, pyrite, and covellite in air; chalcopyrite and pyrite mainly form hematite, and covellite mainly forms chalcocite. Chalcopyrite formed at high temperature is more likely to suffer from laser alteration based on frontier orbital theory, while low-temperature transparent aragonite is not affected by laser power. We also established safe laser power densities for the precise identification of minerals, especially sulfide minerals in air via Raman spectra, which provides references for the laser Raman measurements at the sulfides. The addition of a water drop can effectively prevent the alteration of these minerals under high laser power. Therefore, the effects of high laser power on the *in situ* detection of minerals are negligible, which is conducive to the precise *in situ* analysis of hydrothermal and cold seep systems.



**Figure 1:** The laser alteration of sulfide minerals and barite at different laser powers and safe laser power densities for the minerals.

[1] S. N. White (2009). *Chem. Geol.* **259**, 240-252.

[2] A. Wang et al.(2010). , *J. Raman Spectrosc* **35**, 504–514.

[3] I. Weber et al.(2017). , *J. Raman Spectrosc* **48**, 1-9.