

## Supplementary

The UV-Vis absorption spectra of the studied garnet samples are tested and described below.

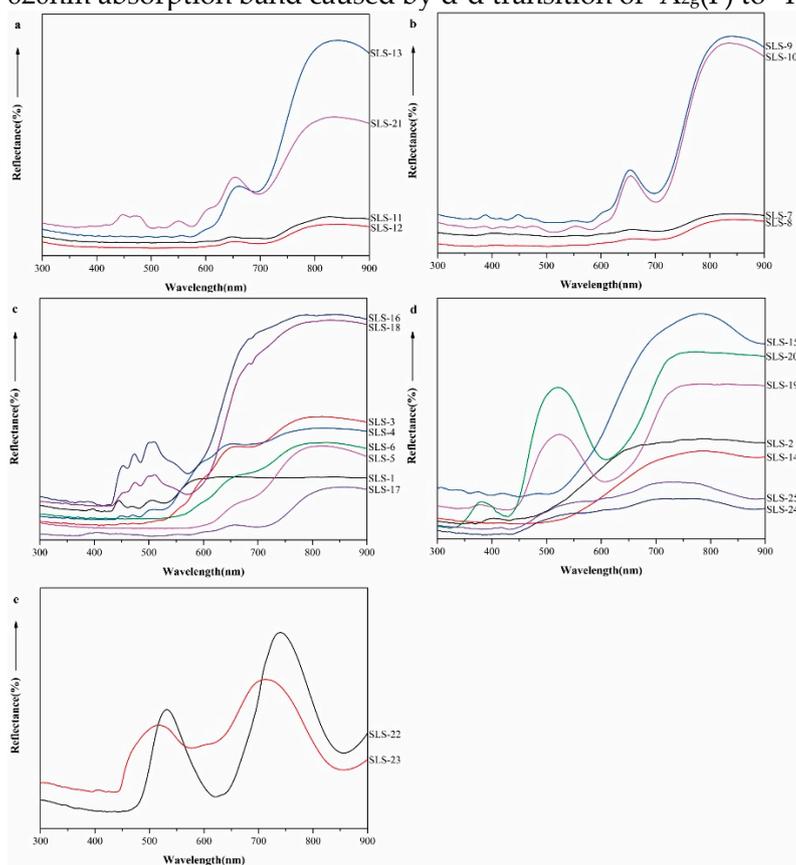
The UV-Vis spectra of pyrope are shown in Figure S1(a), a strong absorption band at 689nm appeared which assignment of Fe<sup>3+</sup> in octahedral site [1]. Other absorption bands at 575, 530 and 505nm are weak, due to the spin-forbidden electron transition of d-d that belong to Fe<sup>3+</sup>. As well as d-d transition 3d<sup>5</sup> of Mn<sup>2+</sup> produce a weak absorption at 460nm [1].

The spectra of Almandine (Figure S1(b)), display a strong absorption band at 700nm as the same as pyrope, induced by Fe<sup>3+</sup>. The electron transition of spectral terms splitting of Fe<sup>2+</sup> 3d<sup>6</sup> induced weak absorption at 581 nm and 460 nm. In octahedral site, it is only had spin-allowed electron transition 5T<sub>2g</sub> to 5E<sub>g</sub> of Fe<sup>2+</sup> [2].

The spectra of spessartite (Figure S1(c)) mainly appeared absorption band of Mn<sup>2+</sup> and Fe<sup>2+</sup>. 460 and 480nm were induced by d-d transition of Mn<sup>2+</sup>. 505 nm weak absorption peak and 525nm absorption band were attributed to <sup>5</sup>E<sub>g</sub> to <sup>3</sup>E<sub>1g</sub>(<sup>3</sup>H) transition of Fe<sup>2+</sup>. <sup>5</sup>E<sub>g</sub> to <sup>3</sup>T<sub>1g</sub>(<sup>3</sup>H) transition of Fe<sup>2+</sup> produced 570nm strong absorption band [3].

In the spectra of grossular (Figure S1(d)), cause the V<sup>3+</sup> substituting for Al<sup>3+</sup> in the octahedral site, tsavorite (SLS-19 and 20) display two strong absorption bands centered at about 430 and 610nm [4].

Andradite (Figure S1(e)) display two strong absorption bands centered at about 440 and 620nm. In octahedral site, Fe<sup>3+</sup> produce 440nm absorption band which is due to the electron transition <sup>6</sup>A<sub>1</sub> to <sup>4</sup>A<sub>1g</sub> + <sup>4</sup>E<sub>g</sub>(G) and Cr<sup>3+</sup> induce 620nm absorption band caused by d-d transition of <sup>4</sup>A<sub>2g</sub>(F) to <sup>4</sup>T<sub>2g</sub>(F) [5].



**Figure S1.** The UV-Vis spectra of gem garnet sample. (a) pyrope; (b) almandine; (c) spessartine; (d) grossular; (e) andradite.

### References

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4. Feneyrol, J.; Giuliani, G.; Ohnenstetter, D.; Rondeau, B.; Fritsch, E.; Fallick, A.E.; Ichang'i, D.; Omito, E.; Rakotondrazafy, M.; Ranastsenho, M.; Lallier, F. New typology and origin of tsavorite based on trace-element chemistry. *European Journal of Mineralogy*. **2014**. *26*, 293-308.
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