

## The new evidence from the fingerprint region in FT-IR spectra to indicate the heat treatment of blue sapphire samples

The FT-IR spectroscopy is a significant method to detect the heat treatment of gemstones, especially, ruby and sapphire. There are set of certain peaks i.e., 3309, 3232, and 3185  $\text{cm}^{-1}$  in the FT-IR spectra using as an indicator to determine whether the samples have been undergone heat treatment. In this study, however, new evidence has emerged. The O-Al-O bending vibration peak at the fingerprint region around 600-700  $\text{cm}^{-1}$  has been suggested as new clues to define the heated stones. The blue sapphire samples from Phrae Province, Thailand were prepared, then the heat treatment was performed separately at 800, 1000, 1200, 1400, and 1650  $^{\circ}\text{C}$  under an oxidizing atmosphere with the soaking time of 1 hour. The energy dispersive X-ray fluorescence (EDXRF) shows that there is no significant difference in the chemical composition of  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{TiO}_2$ , and  $\text{Ga}_2\text{O}_3$  between unheated and heated samples. The alteration of blue color and the UV-Vis absorption spectra are also difficult to classify. When comparing the samples at each heating temperature, the alteration of blue color was not related to one another because the color of the samples was decreased depending on those of the unheated ones. The FT-IR spectra revealed that the broad absorption peak of O-Al-O bending at approximately 650  $\text{cm}^{-1}$  was slightly shifted to a lower wavenumber (630 –635  $\text{cm}^{-1}$ ) after the samples were heated at higher temperatures. The broad absorption peak also turned into the sharper one when the sample has undergone heating at 1000  $^{\circ}\text{C}$  onward. It is suggested that the peak is related to the rearrangement of the  $\text{Al}_2\text{O}_3$  structure of the blue sapphire sample after heat treatment.

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