Investigation of the structure and composition of crystallized substances in the SIAMITE synthesis process to replicate gemstones.

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Introduction

Various minerals and synthetic materials are used to imitate gemstones, such as SIAMITE by FORMICA, a glass-ceramic (SiO_2–Al_2O_3–MgO) with an amorphous structure that forms nanometer-sized crystals. It is transparent and colorful but may contain minor white crystals inclusions. In some pieces, however, white crystals form and cause significant damage during manufacturing and sales. Therefore, this study investigates the structure and chemical composition of these white crystals to improve SIAMITE production and reduce defects.

Materials and Methods

In this study, 5 samples different colours samples of SIAMITE were analyzed using basic instruments for there proporties. The advanced instruments such as Scanning Electron Microscope (SEM), X-ray fluorescence spectrometer (XRF), and Raman spectroscopy were employed for there spectroscopic proporties.

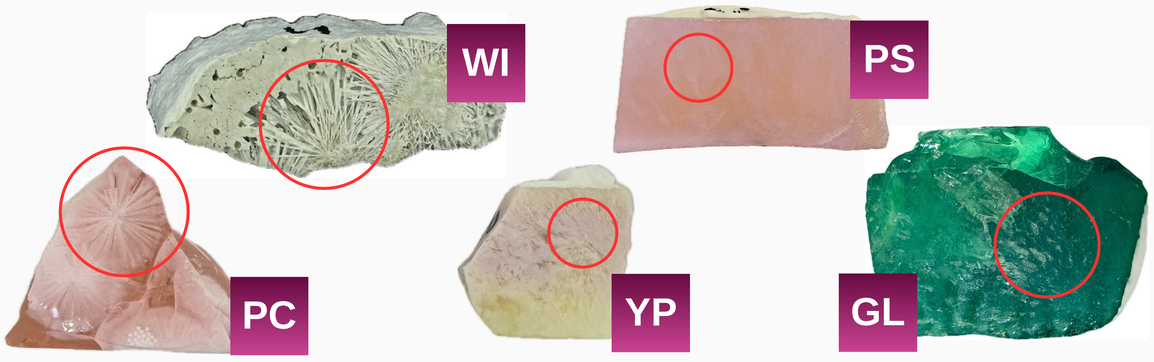


Fig.1 5 sample SIAMITE containing minor white crystals inclusions.

Result

Gemological Microscope

Common inclusions in glass-ceramic, such as gas bubbles or flow lines, were identified, and this white crystal inclusions has an acicular structure arranged in radial and dendritic forms. It is colorless to opaque white.

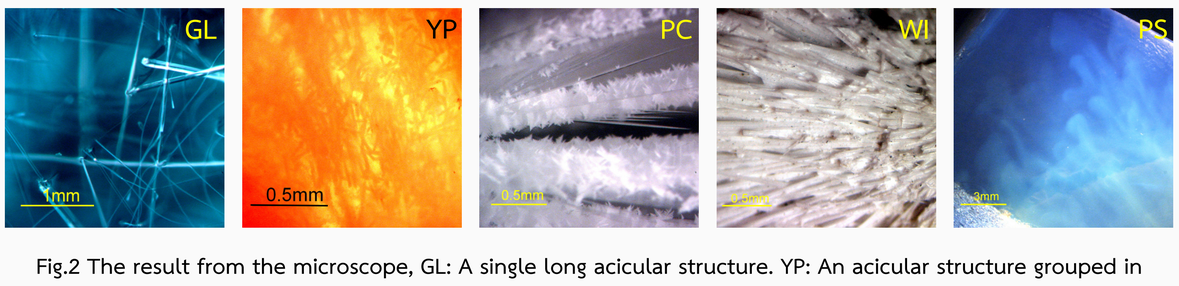


Fig.2 The result from the microscope, GL: A single long acicular structure. YP: An acicular structure grouped in dendritic formations. PC and WI: An acicular structure grouped in radial formations and PS: The white part does not appear as crystals but rather as a thin white haze spread throughout the sample.

X-ray fluorescence spectrometer (XRF)

XRF analysis revealed that Al_2O_3 (~21%), SiO_2 (~62%), and ZnO (~7%). Trace element oxides such as TiO_2, ZrO_2, NiO, As_2O_3, Y_2O_3, and Er_2O_3 were also detected. however, MgO oxides were not detected. The result are displayed in table 1

Element	SiO_2	Al_2O_3	ZnO	ZrO_2	TiO_2	Er_2O_3	NiO	As_2O_3	Y_2O_3	MgO
Mean	62.663	21.918	7.238	4.031	3.385	0.637	0.097	0.028	0.003	bdl

Table.1 The XRF analysis result of minor white crystals inclusions in the average of all 5 samples.

Scanning Electron Microscope (SEM)

SEM revealed that the crystal exhibits hexagonal and square cross-sections, with the crystallization area comprising oxygen (O) (~34%), aluminum (Al), and zinc (Zn) in comparable quantities (~20%). Trace elements identified include 8% silicon (Si), along with 2% sodium (Na), magnesium (Mg), and titanium (Ti) and calcium (Ca), potassium (K), and nickel (Ni) were also detected but in an amount less than 1% . The result contain mainly of Al, Zn and O. The result are displayed in table.2.

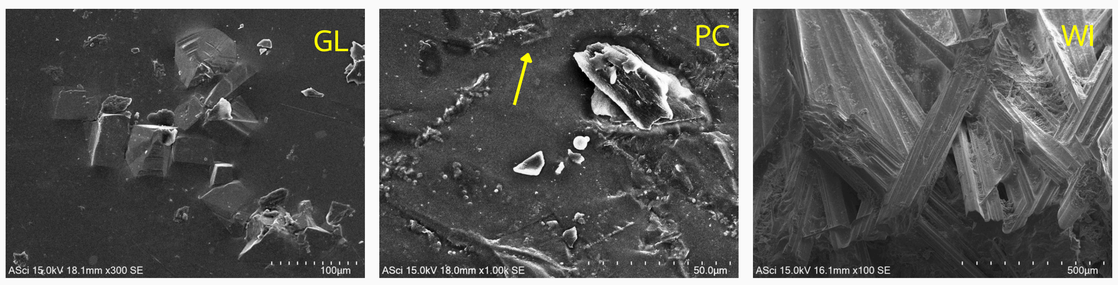
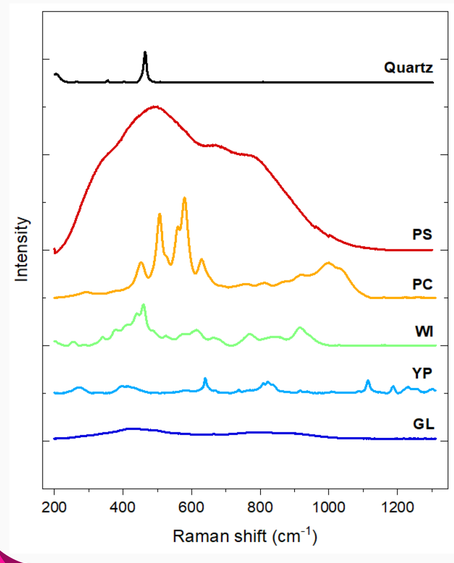


Fig.3 The crystals possess an acicular shape with hexagonal and square cross-sections (GL, PC, and WI).

Element	O	C	Si	Al	Zn	Mg	Zr	Ti	Na
Wt%	35.299	16.322	15.542	14.774	9.846	2.244	2.02	1.804	1.5

Table.2 The SEM analysis result of minor white crystals inclusions in the average of all 5 samples.

Raman spectroscopy



The Raman analysis revealed that the peaks of the compounds in all samples were entirely mismatched. No distinguishable peaks were observed, and the peaks of each sample resembled those of quartz (SiO_2) combined with various other minerals, which include oxides or aluminum.

Fig.4 Results of the minor white crystals inclusions analysis using Raman spectroscopy at a wavelength of 532 nanometers.

Conclusions and Discussions

The results from XRF and SEM suggest the notion that this white crystals inclusions may consist of two mineral types: mullite ($3Al_2O_3{\cdot}2SiO_2$) and willemite (Zn_2SiO_4), which exhibit analogous crystal structures and chemical compositions to the observed crystal. Raman spectroscopy examination indicated that the white crystals exhibit differences in all characteristics, rendering the identification of the substance ambiguous, questioning if the materials in each sample comprise distinct minerals, and how the production process may be optimized. Therefore, additional research must be undertaken to investigate the crystal structure.

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