The structural analysis and surface morphology of quartz has been studied. Quartz has long been known to be a source of silica. X-ray fluorescence (XRF), X-ray diffraction (XRD) and scanning electron microscopy (SEM) were used to observe the surface and internal structure of the quartz. The results among other things revealed that the quartz consist of mainly silica (SiO$_2$), with crystalline structure, microscopic examination showed that the quartz has a porous cellular structure and consists of irregular-shaped particles. This study implies that quartz is good candidate for various applications by ceramic industries.

Key words: Quartz; XRF; XRD; SEM; TGA
Rock crystal is used to make lenses and prisms for optical instruments. Quartz is also used to make glass, mortar, grindstones, sandpaper, and cleaning compounds. It is used as a flux in the smelting of iron and copper ores, and as a glaze for porcelain. Such varieties of quartz as agate, amethyst, onyx, and sardonyx are used as gems (Waltham, 2001).

However, despite these applications of quartz literature on the structural and morphology of quartz has not being reported. Hence therefore, this paper reports the results of an investigation into the structural analysis of quartz using X-ray fluorescence (XRF), Scanning electron micrographs (SEM) and X-ray diffraction (XRD). The aim was to study the structure and surface morphology of quartz.

**Experimental (Methodology)**

The following tests were conducted to characterize the quartz.

**X-ray Fluorescence (XRF)**

X-ray fluorescence (XRF) is the emission of characteristic "secondary" (or fluorescent) X-rays from a material that has been excited by bombarding with high-energy X-rays or gamma rays. The phenomenon is widely used for elemental analysis and chemical analysis, particularly in the investigation of metals, glass, ceramics, building materials and for research in geochemistry, forensic science and archaeology.

The quartz used in this study was obtained from the local supplier (Maju Saintifik Sdn Bhd) Malaysia, which is in powder form. The powders were pressed into pellets with ratio 8:2, powder to wax. The mould pressure used in producing the pellets is 8 tonnes and hold time is one minute. The samples were placed in the XRF machine for elemental analysis. The machine (XRF Bruker S4 Pioneer) was operated at 60 KV.

**Scanning Electron Microscopy**

JOEL-JSM-6380 instrument was used to study the morphology of the quartz which is available at the Mechanical Laboratory, Universiti Tun Hussein Onn Malaysia (UTHM). Small amount of quartz powder was poured on the carbon tape which is attached to the holder. Then the excess powder was blown with air gun to ensure that small pieces of the powder remain on the tape. After that it was put into the SEM chamber for analysis. The SEM machine was operated at operated at 10kV. The magnification of X1000 is used to capture photo of the sample.

**Quartz through X-Ray Diffraction (XRD)**

The quartz samples were subjected to X-Ray Diffraction (XRD) analysis using an X-Ray Diffractometer to determine their silica structure. Prior to analysis, the quartz samples were ground to a powder form by simple pounding using a mortar and pestle due to its brittle nature.

The ground samples were analyzed by Cu Kα radiation with a scanning rate of 0.05° per second 40kV, speed 0.05°/min and scanning at 3° ≥ 2θ ≤ 90°. The X-Ray Diffractometer (Model Bruker D8 Advance) is available for use at the Faculty of Civil Engineering.

**Thermogravimetric Analysis (TGA)**

TGA of the quartz was determined by using Lenseis Thermobalance instrument, in Ceramics and Polymer laboratory UTHM. Information about the thermal properties of TGA especially the point is of great importance to this study. The TGA observation can give the temperature change of the sample to obtain suitable sintering temperature. To do the test little amount of TGA powder (24.6mg) was used for the heating and cooling. The speed of the test was 10°C/minutes and the maximum temperature 1000°C.

**Results and Discussion**

X-Ray Fluorescence (XRF) analysis is proficient in analyzing material contents inside the raw materials, hence the amount of SiO₂ can be observed. The presence of various compounds within quartz raw material can be seen in Table 2. This establishes the result of XRF analysis of quartz raw material. It is evident that SiO₂ is the major composition in the entire raw materials quartz raw material with 99.40 wt% followed by alumina with 0.22 wt%.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Composition</th>
<th>SiO₂</th>
<th>Al₂O₃</th>
<th>FeO₂</th>
<th>CaO</th>
<th>K₂O</th>
<th>P₂O₅</th>
<th>MgO</th>
<th>SO₃</th>
<th>Na₂O</th>
<th>MnO</th>
<th>TiO₂</th>
<th>CO₂</th>
<th>LOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td></td>
<td>99.40</td>
<td>0.22</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.10</td>
</tr>
</tbody>
</table>

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Figure 1: SEM of Quartz

Figure 1 shows the quartz particles; the particles were irregular in shape and having porous texture. In addition, there was no agglomeration of quartz particles.

Figure 2 is the qualitative XRD analysis of the quartz raw material. One major phase identified is quartz hexagonal (ICDD 00-3755). This result is supportive of XRF result presented in Table 1.

Quartz revealed a unique weight change profile upon heating (Figure 3) with a weight loss as the temperature increases. The weight drop profile exhibited by the quartz in the temperature range of 21 °C to 940°C is identical to that exhibited during the dehydration of the hydroxyl groups in kaolinite.
CONCLUSION
Quartz is a valuable natural resource not only as a good source of silica, but also as a source of lignocellulosic material which can be potentially used to produce arange of valuable products. However, product development will require greater understanding of the quartz. The information provided here could form both a useful background on the compositional and morphological characteristics of the quartz surface as well as its internal tissues. Therefore the extension of knowledge on structural analysis and surface morphology of this quartz is very important for the determination of which type quartz to be used by the industries.

RECOMMENDATIONS
Therefore the extension of knowledge on Differential Thermal Analysis of this quartz is very important for the determination of which type quartz to be used by the industries.

CONTRIBUTIONS OF AUTHORS
The Author wishes to register his gratitude to the following; Asso. Prof. Mohammad Zaky bin Noh and Prof. Zainal Ariffin Ahmad for their guidance during the conduct of this experiment.

ACKNOWLEDGEMENT
The authors would like to acknowledge the financial support of Universiti Tun Hussein Onn Malaysia. We would also like to thank the following: Mr. Mohd Azrul Nizam bin Mustari, Mr. Fazlannuddin Hanur bin Harith, Mr. Shahrul Mahadi bin Samsudin, Mr. Mohd Tarmizi bin Nasir, Mr. Anuar bin Ismail, and Mr. Ahmad Nasrull bin Mohamed for their assistance as laboratory technicians.

REFERENCES


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