Grossmanite

\[ \text{Ca}(\text{Ti}^{3+}, \text{Mg}, \text{Ti}^{4+})\text{AlSiO}_6 \]

**Crystal Data:** Monoclinic.  
Point Group: 2/m.  
Coating spinel grains as irregular masses 1-7 \( \mu \)m.  
Twinning: None observed.

**Physical Properties:** Cleavage: n.d.  
Tenacity: n.d.  
Fracture: n.d.  
Hardness = n.d.  
D(meas.) = n.d.  
D(calc.) = 3.41

**Optical Properties:** Transparent.  
Color: Light gray in thin-section.  
Streak: n.d.  
Luster: n.d.

**Cell Data:** Space Group: C2/c.  
\( a = 9.80 \)  
\( b = 8.85 \)  
\( c = 5.36 \)  
\( \beta = 105.62^\circ \)  
\( Z = 4 \)

**X-ray Powder Pattern:** Allende meteorite.  
2.996 (100), 2.535 (47), 2.581 (42), 2.964 (31), 2.600 (28), 2.909 (25) 2.130 (19)

**Chemistry:**

<table>
<thead>
<tr>
<th>Element</th>
<th>Formula</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td></td>
<td>27.99</td>
<td>25.14</td>
</tr>
<tr>
<td>Al₂O₃</td>
<td></td>
<td>24.71</td>
<td>21.33</td>
</tr>
<tr>
<td>CaO</td>
<td></td>
<td>24.58</td>
<td>23.46</td>
</tr>
<tr>
<td>Ti₃O₃</td>
<td></td>
<td>10.91</td>
<td>30.08</td>
</tr>
<tr>
<td>TiO₂</td>
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<td>6.68</td>
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</tr>
<tr>
<td>MgO</td>
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<td>4.45</td>
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<tr>
<td>Sc₂O₃</td>
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<td>0.43</td>
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<tr>
<td>V₂O₃</td>
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<tr>
<td>ZrO₂</td>
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<td>0.13</td>
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<tr>
<td>FeO</td>
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<td>0.08</td>
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</tr>
<tr>
<td>Cr₂O₃</td>
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<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100.20</td>
<td>100.01</td>
</tr>
</tbody>
</table>

(1) Allende meteorite; average electron microprobe analysis supplemented by Raman spectroscopy, total Ti as 18.80 w% TiO₂ was partitioned between Ti\(^{3+}\) and Ti\(^{4+}\) to make ideal stoichiometry; corresponds to \( \text{Ca}_{1.00}[\text{Ti}^{3+}0.35\text{Al}_{0.18}\text{Sc}_{0.01}\text{V}^{3+}0.01\text{Mg}_{0.25}\text{Ti}^{4+}0.19]\text{Si}_{2.01}\text{Al}_{0.93}\text{O}_{6}\).  
(2) \( \text{CaTi}^{3+}\text{AlSiO}_6 \).

**Mineral Group:** Clinopyroxene group.

**Occurrence:** Likely formed through high-temperature condensation in the solar nebula, followed by melting and crystallization in Ca-,Al-rich refractory inclusions in a meteorite.

**Association:** Spinel, perovskite, grossite, melilite.

**Distribution:** In the Allende meteorite.

**Name:** Honors Lawrence Grossman (b. 1946), Professor of Cosmochemistry, University of Chicago, USA, for his fundamental contributions to meteorite research.

**Type Material:** National Museum of Natural History, Washington D.C., USA (USNM 7562).