Heating Microscopes EM201 & EM301

Alumina (Al$_2$O$_3$) Substrates

1 Introduction

In this information sheet you will learn which substrates are commonly used in a Hesse Instruments heating microscope, how the different substrates differ from one another and which influence they have on the results of a heating microscope measurement.

» Basic Information

The plate on which the specimen is placed during a heating microscope measurements is called substrate. It is placed on the specimen holder, which is moved into the furnace of the heating microscope.

The substrate protects the specimen holder and measuring chamber against contamination caused by the melting specimen. Furthermore its upper front edge forms the base line for the automatic image analysis.

The material of a substrate has a direct influence on the result of a heating microscope measurement, because every substrate material is wetted to a different degree by the deforming or melting specimen.

You will find further information about the wettability of substrates made of various materials by different sample materials in our application report Influence of the Substrate Material on Results of Hesse Instruments' Heating Microscope EM301.

The underlying standards for the determination of the fusibility of ashes, demand the use of substrates made of platinum. However, in order to limit costs and for reasons of practicality, availability and high chemical resistance substrates made of aluminium oxide (Al$_2$O$_3$) have become established in the past and are almost exclusively used for heating microscope measurements.

» Features and benefits of Hesse Instruments' substrates

Two different qualities of substrates are offered by Hesse Instruments as a standard product:

<table>
<thead>
<tr>
<th>EZ-A121/997</th>
<th>EZ-A101/96</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Composition</strong></td>
<td>99.7 % Al$_2$O$_3$</td>
</tr>
<tr>
<td><strong>Length x width x height</strong></td>
<td>12 mm x 10 mm x 1.5 mm</td>
</tr>
<tr>
<td><strong>Production process</strong></td>
<td>Die pressed, Surface &quot;as fired&quot;, planar</td>
</tr>
</tbody>
</table>
**Information Sheet for Heating Microscopes EM201 & EM301**

**Alumina (Al₂O₃) Substrates**

<table>
<thead>
<tr>
<th></th>
<th>EZ-A121/997</th>
<th>EZ-A101/96</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Maximum temperatures</strong></td>
<td>Temperatures up to ca. 1700 °C</td>
<td>Temperatures up to ca. 1600 °C</td>
</tr>
<tr>
<td><strong>Characteristics</strong></td>
<td>Provided that the specimen does not react with alumina:</td>
<td>Provided that the specimen does not react with Alumina:</td>
</tr>
<tr>
<td></td>
<td>... Chemically resistant to corrosive and aggressive melts</td>
<td>... Chemically resistant to most standard glazes and enamels or oxide ceramics</td>
</tr>
<tr>
<td></td>
<td>... Protection of the specimen holder due to a high barrier property of the 1.5 mm thick substrate</td>
<td></td>
</tr>
<tr>
<td><strong>General application</strong></td>
<td>Applicability in the high temperature range of about 1700 °C, depending on furnace atmosphere and specimen composition.</td>
<td>Applicability in the high temperature range of about 1600 °C, depending on furnace atmosphere and specimen composition.</td>
</tr>
<tr>
<td><strong>Recommended application</strong></td>
<td>Measurement of ashes: coal ashes, ashes of solid recovered fuels, waste incineration, or any solid bio fuel; measurement of foundry products (iron or non-ferrous)</td>
<td>Measurement of glass, glazes, vitreous enamels and any ceramic material</td>
</tr>
</tbody>
</table>

**Benefit**

Optimal level of safety  
Cost-saving

**Influence of Hesse Instruments' substrates on the measurement result**

In order to determine the influence of the material of Hesse Instruments' substrates on the result of a heating microscope measurement, two measurement series were carried out with substrates made of 99.7 % Al₂O₃ and one measurement series with substrates made of 96.0 % Al₂O₃. The influence of the material is illustrated below in form of a bar diagram and two tables.

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**Comparison of the Characteristic Temperatures using Substrates with Al₂O₃ contents of 96% and 99.7%**

<table>
<thead>
<tr>
<th>Characteristic Temperature</th>
<th>96% Measurement Series 1</th>
<th>99.7% Measurement Series 1</th>
<th>99.7% Measurement Series 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of Sintering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deformation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sphere</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemisphere</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flowing</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Temperature / °C**

600  
700  
800  
900  
1000  
1100  
1200  
1300
### Evaluation of the individual measurements

<table>
<thead>
<tr>
<th>Name of the measurement</th>
<th>Purity of the substrates</th>
<th>S: Start of Sintering</th>
<th>A: Deformation</th>
<th>B: Sphere</th>
<th>C: Hemisphere</th>
<th>D: Flowing</th>
</tr>
</thead>
<tbody>
<tr>
<td>110606_1</td>
<td>96</td>
<td>623</td>
<td>815</td>
<td>893</td>
<td>1074</td>
<td>1283</td>
</tr>
<tr>
<td>110606_3</td>
<td>96</td>
<td>623</td>
<td>816</td>
<td>895</td>
<td>1073</td>
<td>1283</td>
</tr>
<tr>
<td>110607_2</td>
<td>96</td>
<td>613</td>
<td>818</td>
<td>900</td>
<td>1083</td>
<td>1276</td>
</tr>
<tr>
<td><strong>Average 96 / °C</strong></td>
<td></td>
<td><strong>60</strong></td>
<td><strong>816</strong></td>
<td><strong>896</strong></td>
<td><strong>1077</strong></td>
<td><strong>1281</strong></td>
</tr>
<tr>
<td><strong>Standard deviation 96 / °C</strong></td>
<td></td>
<td><strong>6</strong></td>
<td><strong>2</strong></td>
<td><strong>4</strong></td>
<td><strong>6</strong></td>
<td><strong>4</strong></td>
</tr>
<tr>
<td><strong>Standard deviation 96 / %</strong></td>
<td></td>
<td><strong>0,9</strong></td>
<td><strong>0,2</strong></td>
<td><strong>0,4</strong></td>
<td><strong>0,5</strong></td>
<td><strong>0,3</strong></td>
</tr>
<tr>
<td>110601_3</td>
<td>99,7</td>
<td>618</td>
<td>826</td>
<td>894</td>
<td>1063</td>
<td>1272</td>
</tr>
<tr>
<td>110606_2</td>
<td>99,7</td>
<td>615</td>
<td>826</td>
<td>890</td>
<td>1110</td>
<td>1277</td>
</tr>
<tr>
<td>110607_1</td>
<td>99,7</td>
<td>608</td>
<td>817</td>
<td>894</td>
<td>1089</td>
<td>1271</td>
</tr>
<tr>
<td><strong>Average 99 / °C</strong></td>
<td></td>
<td><strong>614</strong></td>
<td><strong>823</strong></td>
<td><strong>893</strong></td>
<td><strong>1087</strong></td>
<td><strong>1273</strong></td>
</tr>
<tr>
<td><strong>Standard deviation 99 / °C</strong></td>
<td></td>
<td><strong>5</strong></td>
<td><strong>5</strong></td>
<td><strong>2</strong></td>
<td><strong>24</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td><strong>Standard deviation 99 / %</strong></td>
<td></td>
<td><strong>0,8</strong></td>
<td><strong>0,6</strong></td>
<td><strong>0,3</strong></td>
<td><strong>2,2</strong></td>
<td><strong>0,3</strong></td>
</tr>
<tr>
<td>110614_1</td>
<td>99,7</td>
<td>612</td>
<td>810</td>
<td>895</td>
<td>1090</td>
<td>1257</td>
</tr>
<tr>
<td>110616_1</td>
<td>99,7</td>
<td>624</td>
<td>815</td>
<td>893</td>
<td>1106</td>
<td>1261</td>
</tr>
<tr>
<td>110616_3</td>
<td>99,7</td>
<td>620</td>
<td>823</td>
<td>895</td>
<td>1097</td>
<td>1263</td>
</tr>
<tr>
<td><strong>Average 99 / °C</strong></td>
<td></td>
<td><strong>619</strong></td>
<td><strong>816</strong></td>
<td><strong>894</strong></td>
<td><strong>1098</strong></td>
<td><strong>1260</strong></td>
</tr>
<tr>
<td><strong>Standard deviation 99 / °C</strong></td>
<td></td>
<td><strong>6</strong></td>
<td><strong>7</strong></td>
<td><strong>1</strong></td>
<td><strong>8</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td><strong>Standard deviation 99 / %</strong></td>
<td></td>
<td><strong>1,0</strong></td>
<td><strong>0,8</strong></td>
<td><strong>0,1</strong></td>
<td><strong>0,7</strong></td>
<td><strong>0,2</strong></td>
</tr>
</tbody>
</table>

### Evaluation of all measurements

<table>
<thead>
<tr>
<th></th>
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<th>C: Hemisphere</th>
<th>D: Flowing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average of all measurements / °C</strong></td>
<td>617</td>
<td>818</td>
<td>894</td>
<td>1087</td>
<td>1271</td>
</tr>
<tr>
<td><strong>Total standard deviation / °C</strong></td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total standard deviation / %</strong></td>
<td>0,5</td>
<td>0,5</td>
<td>0,2</td>
<td>1,0</td>
<td>0,8</td>
</tr>
</tbody>
</table>