Alumina Polishing Abrasives

Modern nanometer alumina or polycrystalline seeded jell alumina abrasives outperform traditional calcined alumina abrasives for fine surface finishing. In general, alumina abrasives are classified by their manufacturing process, crystal structure (hardness) and their sizing or classification process. The seeded jell alumina abrasives have a much tighter and better controlled particle size distribution and are ideal for fine polishing, whereas the calcined alumina powders are relatively inexpensive and are very useful for coarse polishing.

<table>
<thead>
<tr>
<th>Alumina</th>
<th>Product name</th>
<th>Processing / form</th>
<th>pH</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcined</td>
<td>Alumina powders</td>
<td>Dry / powder</td>
<td>n.a</td>
<td>Low cost abrasive for polishing hard materials</td>
</tr>
<tr>
<td>Seeded jell</td>
<td>Nanometer acidic alumina</td>
<td>Wet / slurry</td>
<td>4.0</td>
<td>Excellent polish for metals, especially for CMP (chemical mechanical polishing) with low pH or acid solutions.</td>
</tr>
<tr>
<td>Seeded jell</td>
<td>Nanometer alumina</td>
<td>Wet / slurry</td>
<td>10.0</td>
<td>Excellent fine abrasive polish. High pH allows for better dispersion of alumina particles in slurry.</td>
</tr>
</tbody>
</table>

Seeded Jell Alumina

The primary advantage of seeded jell alumina or polycrystalline alumina is that it can be produced in a very fine particle size with very narrow particle size distributions. This is particularly important for polishing, especially for polishing softer metals or materials which have inclusions (e.g. copper, certain steels and aluminum).

Other advantages of seeded jell processing is that the harder alpha crystal particle can be produced in the submicron particle size, and thus has higher durability and performance as compared to calcined gamma alumina. The seeded jell alumina particle is also a polycrystalline particle and thus has a greater number of cutting points as opposed to the flat platlety particles formed during the calcining process.

0.05 um Calcined gamma alumina

0.20 um seeded jell alpha alumina

Considerations for proper Alumina polishing

- Particle size distribution
- Polishing solution chemistry
- Reactivity of specimen at either low or high pH values
- Proper selection of the polishing pad
Seeded Jell Alumina Continued

The processing of seeded jell alumina is accomplished by properly controlling the solution pH and electrochemistry of the solution. Thus the polycrystalline acidic Nanometer alumina polish is processed at a low pH value of 4 and the basic or standard Nanometer alumina is processed at a pH of 10. At these pH values, the surface chemistry of the alumina particles is optimized for minimizing particle agglomeration, thus producing a much smaller and tighter particle size distribution.

Calcined Alumina

Calcined alumina powders have been the traditional final polishing abrasive for many years and is relatively inexpensive and readily available. The issue with the calcined powders is the agglomeration issue created by processing this type of alumina, as dry powders create particle agglomeration. For larger particles (>600 grit), the agglomeration is less significant, however for smaller particle agglomeration can be a problem. For example, the agglomerated or standard version of a 0.05 um alumina crystal can form an agglomerate size as large as 40 um. When polishing hard samples these agglomerates can often be broken down, however for soft materials such as aluminum, copper, zinc, etc. these fine agglomerated abrasives can form large random scratches.

Agglomerated vs. Deagglomerated

The term agglomeration refers to the electrostatic attraction of small particles to each other. This arises from the fact that all surfaces have an unbalanced surface charge. For small particles, the surface area of the alumina particles becomes relatively large compared to their volume, thus surface charge and agglomeration forces take over causing agglomeration. This is particularly true for alumina's such as calcined alumina which are processed in the dry condition.

The term deagglomeration refers to the process by which dry agglomerated particles are milled or broken down. The process for deagglomeration of dry powders is to blast the agglomerated powder at each other at high velocities, thus breaking down the agglomerate size. Note this deagglomeration process is only moderately successful.

CMP (chemical mechanical polishing)

Nanometer alumina polishes are available in either a low pH 4 or a high pH 10 slurry; therefore, they make ideal CMP polishes. The goal of CMP polishing is to match the chemical dissolution of the sample with its mechanical abrasion. The result is the ability to remove the damaged layer both mechanically and chemically. CMP polishing is particularly useful for hard to polish samples such as niobium, tin solders, zinc and other hard to polish specimens.

To enhance the chemical effects of the polish, a light or less reactive chemical etchant can be used. The results can be very surprising.

“Seeded jell alumina abrasives are one of the most significant polishing abrasive advances over the last 50 years.”
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