Quality Matters Newsletter

Automated Specimen Preparation – Relative Velocity

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Automated Specimen Preparation

Automated specimen preparation allows for more consistent and controlled polishing results via more uniform application of pressure and more uniform use of the polishing or grinding surface. The polishing process as described by Preston's Law shows that the grinding rate is proportional to the polishing / grinding velocity multiplied by the applied grinding load.

$$R = kVP$$ (Preston's Law)

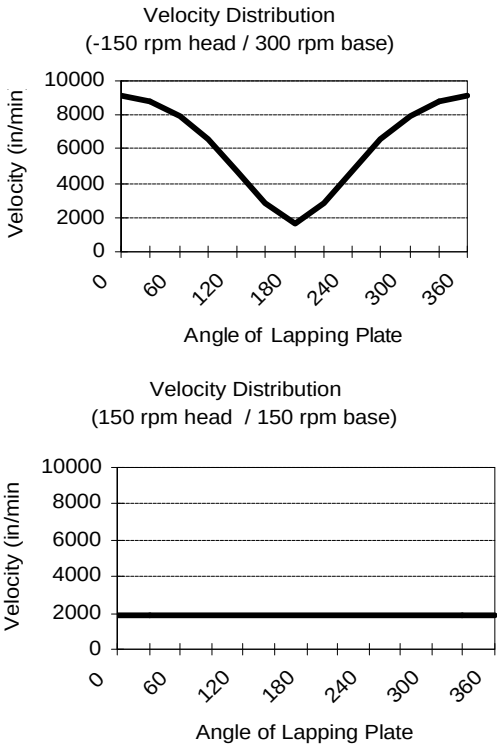
R - Grinding rate
V - Relative polishing velocity
P - Polishing pressure

Automated Specimen Preparation Machine

Relative Velocity

Current grinding / polishing machines are designed with the specimens mounted in a disk holder and rotated on a abrasive disk working surface. This disk-on-disk rotation allows for a variable velocity distribution depending upon the head speed relative to the base speed.

For high stock removal, a slow head speed or a higher head speed rotating in the opposite direction relative to a high base speed produces the most aggressive grinding / polishing operation. The adjacent diagram for -150 rpm contra head direction and 300 rpm base speed shows that the maximum velocity is approximately 9000 inches per minute at the outside of the abrasive surface. Conversely, the minimum velocity of 2000 inches per minute is at the center of the abrasive surface. This cycling or pulsing action and high velocity distribution produces a very aggressive grinding operation and is ideal for rough, or planar grinding.



Inside this issue:

Considerations for automated specimen preparation

- Relative velocity distribution
- Single vs. multiple specimen preparation
- MRD (Material removal differential
- Types of specimen automation

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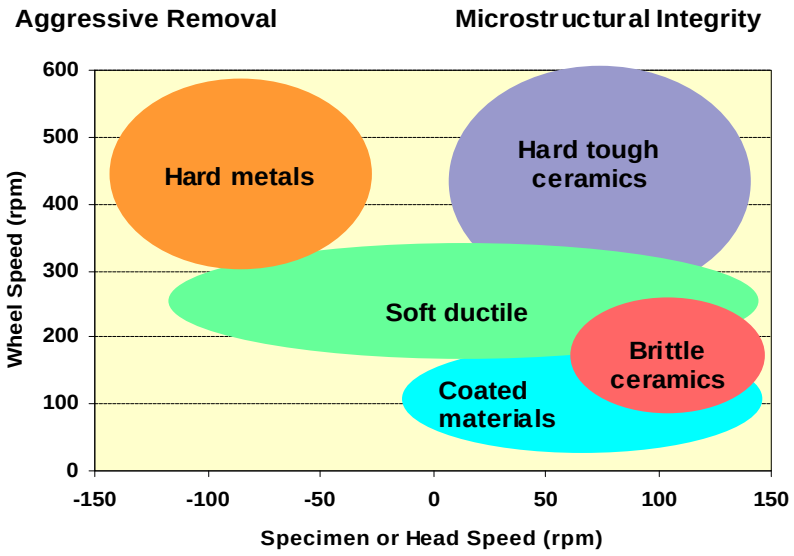
Polishing - To maintain microstructural features, the operator should minimize the aggressiveness of the polishing step with a constant relative velocity distribution. This condition is achieved by rotating the specimen at roughly the same rpm and in the same direction as the base platen. The adjacent plot for 150 rpm head and 150 rpm base shows a constant, but relatively low, velocity distribution.

In practice, a combination of a high velocity distribution (-150 rpm head speed / 300 rpm base speed) for the initial planarization or stock removal step, followed by a moderate speed and low velocity distribution (120-150 rpm head speed / 150 rpm base speed) step is recommended for producing relatively flat specimens.

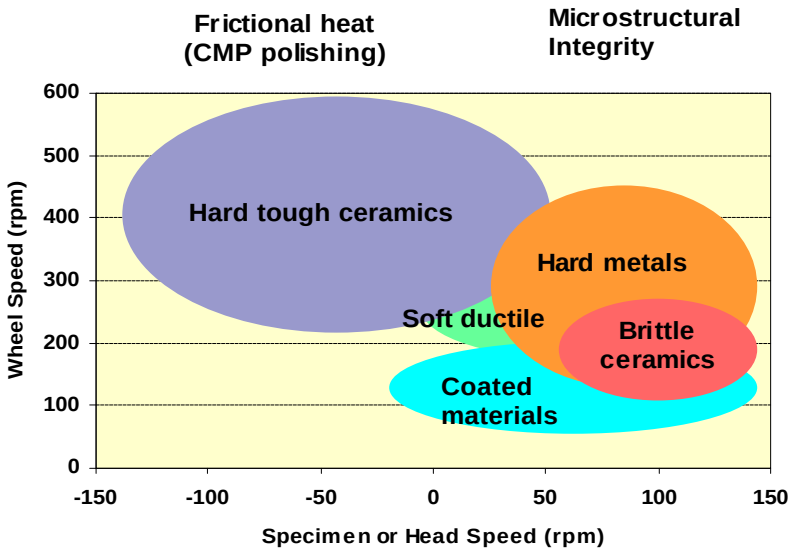
For final polishing under chemical mechanical polishing (CMP) conditions (where frictional heat can enhance the chemical process), high speeds and high relative velocity distributions can be useful (e.g. monolithic ceramics such as silicon nitride and alumina

Planar Grinding Recommendations



"High stock removal requires a high Relative velocity distribution; whereas, maintaining microstructural features are best accomplished with a nearly constant velocity distribution"

Rough Polishing Recommendations



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