Characterization and Control of Subsurface Damage in Grinding Titanium Aluminide (γ)

Precision Machining Research Consortium
Industrial Advisory Board
Georgia Institute of Technology
29 October 1997

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**Methodology**

- Choose a broad range of grinding conditions
- Monitor force and power consumption in real time
- Quantify the generated plastic deformation
- Correlate the depth of damage with process inputs
- Correlate the process inputs with machine inputs
- Validate the model
- Implement the controller to minimize damage
Experimental Setup

- Dynamicsometer
- Amplifier
- Power Transducer
- Aliasing Filter

DAQ

Computer
Grinding Process

- Grinding wheel
- Rubbing (sliding)
- Ploughing (chip formation)
- Bond
- Path of grain C
- Path of grain B

Workpiece
Generation of Subsurface Damage:

Section

Polish Sides

Glue & Clamp

Grind

Separate

Microscopy and Laser

Type/Depth of Damage

polished tops

as-cast surface subjected to grinding

grind surface with specific grinding conditions

damage depth

polished

unglue sample & investigate by OM & SEM
**Measurement** of Depth of Damage

**Average Depth of Damage**

$$\bar{h} = \frac{\sum_{i=1}^{n} h_i}{n}$$

Correlated to Different Grinding Conditions
Average Depth of Damage

365 µm

damage depth
Damage Depth vs Depth of Cut

Depth of Cut \( a \) (\( \text{\(\mu\)m} \))

- \( q=1800, V_s=30, V_w=1 \)
- \( q=4320, V_s=36, V_w=0.5 \)
- \( q=3600, V_s=30, V_w=0.5 \)
**Relationship between $h$ and $heq$**

Equivalent Grinding Thickness $heq = a/q$ (nm)

Depth of Damage $h$ ($\mu$m)

- $q=3600$, $Vs=30$, $Vw=0.5$
- $q=4320$, $Vs=36$, $Vw=0.5$
- $q=1800$, $Vs=30$, $Vw=1$
## Contribution

- Identify quantities that are involved in defining workpiece quality
- Establish limits for subsurface damage and effects
- Relate subsurface damage characteristics to process variables
- Identify parameters that must be controlled to achieve desired quality
- Develop mechanistic process model for grinding operation
- Increase knowledge and understanding of the grinding operation