Characterization of “Wide Peening Cleaning” Die Surfaces for Automotive Applications

Student Names: Regina Park, Harry Amadeo, Ethan Chang, Sherine Mathew
Faculty Advisors: Dr. Jeffery Youngblood, Dr. Mark Gruninger
Industrial Sponsors: Shota Watanabe, Larry Catanzaro

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Abstract: This study aims to assess the effectiveness of Wide Peening Cleaning (WPC) treatment in enhancing the mechanical properties and wear characteristics of automotive-grade steel commonly used in dies. The baseline steel, SUS440C was selected for initial evaluation and is representative of materials prevalent in automotive dies. Test coupons of the SUS440C steel went through comprehensive analyses including surface stress, hardness, roughness, and sliding wear tests, serving as benchmarks for comparison. Subsequently, additional steel samples were subjected to either traditional shot peening or the advanced WPC treatment. These treated samples underwent identical testing protocols as the untreated baseline samples to evaluate the impact of each treatment method on material properties and wear resistance.

Results & Discussion

Hardness Testing

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Hardness (HRC)</th>
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<tbody>
<tr>
<td>As Heated</td>
<td>56.9 ± 2.9</td>
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<tr>
<td>Shot Peened</td>
<td>56.2 ± 2.5</td>
</tr>
<tr>
<td>WPC</td>
<td>57.8 ± 3.1</td>
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- Most of the samples retained their heat-treated hardness of about 57, with the exception of some unusually low hardness measurements.
- The low hardness data exhibited far greater variability and inaccuracy is difficult to explain and/or substantiate.

Residual Stress Testing

- Compressive residual stress for both WPC coupon thicknesses is higher than the stress for SP test coupons at the surface (0.00 mm).
- Indicates that peening successfully induced hardness into the material.

Conclusions & Future Work

- With the exception of some unusually and difficult to explain low hardness measurements, neither shot peening or WPC significantly changed sample hardness.
- While hardness did not appear to be changed by shot peening or WPC, other measurements also demonstrated “classic benefits” associated with “peening.” The surface residual stresses of the WPC and SP specimens significantly exceed those of the as-heated specimens.
- In wear testing, the SP and WPC specimens both surpass the resistance of the as-heated specimens, with a 62% and 57% decrease in wear respectively.
- According to surface roughness data, the WPC parts are smoother than the SP parts, but roughness will differ on a case-by-case basis.
- Overall, both WP and shot peening produce surfaces with improved mechanical characteristics over the baseline.
- Future work considerations include a corrosion testing series especially for automotive components.
- Additionally, development of a Finite Element Analysis (FEA) model to simulate mechanical behavior of parts in use.

References


MSE Senior Design