Abstract

The demand for micro products has increased gradually since last decades in various areas, requiring the development of micro manufacturing processes. Micro manufacturing is characterized by the size of functional features (less than 10 mm), a high precision, a good surface finishing and complex parts in a wide variety of materials. The Traditional Machining Processes (TMPs) are intensively used to produce micro-components, but the minimum feature size they can produce is limited [1]. In parallel, the Nontraditional Machining Processes (NMPs) were developed to manufacture micro components of a few microns, but the processing times are slower [2]. Hybrid Machining Processes (HMPs) were introduced to address the demand to increase production with an enhanced quality for difficult-to-machine materials such as ceramics [3]. The HMP considered is a combination of micro-milling and laser machining which is developed to machine ceramic materials. This HMP may be carried out at different stages in the ceramic production. The goal is to determine the most attractive production stage in ceramic machining with this HMP.

Material

- Y-TZP ceramic
- Transformation toughening

<table>
<thead>
<tr>
<th>Process Zone</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td>1. Processing zone</td>
<td>Limited remelting Tool contact</td>
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<td>2. Unstable tetragonal particle</td>
<td>Tool contact Roughness control</td>
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<td>3. Stable monoclinic particle which transformed</td>
<td>Tool non-contact Processing</td>
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<td>4. Tetragonal particle during processing</td>
<td>Excellent remelting Laser Machining</td>
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</tbody>
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Hybrid Machining

- Milling
- Hybrid Machining
- Laser Machining

Ceramic production with several production stage

- Shaping the green body
- Pre-firing
- Sintering
- Inspection

Green Machining | White Machining | Hard Machining

Conclusion

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<tr>
<th>Machining</th>
<th>Micro-milling</th>
<th>Laser Machining</th>
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<tr>
<td>Hard Machining</td>
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<tr>
<td>White Machining</td>
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<td>Green Machining</td>
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Bibliography