Additive Manufacturing of Carbides using Renewable resources

Monsur Islam and Rodrigo Martinez-Duarte

Mechanical Engineering Department, Clemson University, Clemson, SC, USA

WHAT?
A novel additive manufacturing process of carbides using a biopolymer-metal oxide composite as the precursor material.

WHY?
- Energy efficient approach to make carbide parts by using renewable resources as precursor and lower process temperature.
- Additive manufacturing of a precursor gel composite to make intricate shapes, challenging for present commercial techniques.

HOW?
- Extrusion of biopolymer-metal oxide nanoparticle gel composite followed by heat treatment in inert atmosphere

Introduction

Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Source</th>
<th>Role in our work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iota-carrageenan (IC)</td>
<td>Red seaweed</td>
<td>Carrier</td>
</tr>
<tr>
<td>Cellulose</td>
<td>Plant</td>
<td>Bio-filler</td>
</tr>
<tr>
<td>Chitin</td>
<td>Exoskeleton of shrimp, crab and lobsters</td>
<td>Bio-filler</td>
</tr>
<tr>
<td>Tungsten trioxide (WO₃)</td>
<td>-</td>
<td>MONP</td>
</tr>
</tbody>
</table>

Reaction Parameters

\[ \text{WO}_3 + 4C \rightarrow WC + 3CO \]

Experimental Procedure

Results

Additive Manufacturing

- Successfully synthesized WC
- Retains shape, shrinkage occurs
- Explore lower temperature synthesis
- Explore other carbide synthesis

Conclusion & Future Work

- Electron Microscopy Laboratory
- X-Ray Facilities of The Molecular Structure Centre @ Clemson University

Acknowledgement

THANK YOU!