<table>
<thead>
<tr>
<th>Title</th>
<th>Synthesis and characterization of nanothermite system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author(s)</td>
<td>Tan, Gibson Kuan Han</td>
</tr>
<tr>
<td>Citation</td>
<td>Tan, G. K. H. (2011, March). Synthesis and characterization of nanothermite system. Presented at Discover URECA @ NTU poster exhibition and competition, Nanyang Technological University, Singapore.</td>
</tr>
<tr>
<td>Date</td>
<td>2011</td>
</tr>
<tr>
<td>URL</td>
<td><a href="http://hdl.handle.net/10220/8969">http://hdl.handle.net/10220/8969</a></td>
</tr>
<tr>
<td>Rights</td>
<td>© 2011 The Author(s).</td>
</tr>
</tbody>
</table>
1. BACKGROUND

Thermite system, which comprises of a metal fuel and metallic or non-metallic oxide, will result in a highly exothermic reaction upon ignition. Energy release rate in this system is mainly inhibited by the mass transport via diffusion process in solid state. However, energy release rate can be improved by reducing the scale of both fuel and oxidizer, resulting in increased interfacial contact area between the precursors. Hence, nanothermite have significantly improved combustion properties than their traditional micron-sized counterpart. Al-Fe₂O₃ mixtures are widely studied due to their availability and high energy density [1]. In this work, combustion properties of Al-Fe₂O₃ nanothermite system in varying fuel/oxidizer ratios (F/O) and oxidizer morphologies were studied. The stoichiometric ratio of Al-Fe₂O₃ is given by the equation below:

\[
\text{Fe}_2\text{O}_3 (s) + 2\text{Al}(s) \rightarrow 2\text{Fe}(s) + \text{Al}_2\text{O}_3(s)
\]

2. PREVIOUS WORK

Recently, self-assembly using poly(4-vinylpyridine) was successfully employed; resulting in increased interfacial contact area between Al (fuel) and Fe₂O₃ nanotubes (oxidizer), and improved reaction kinetics [2]. However, solution phase synthesis [3] used, produces low yield of Fe₂O₃ nanotubes. Hence, studies on the solution phase synthesis of Fe₂O₃ was done to understand the parametric relationships [4]. As shown below, dosages of precursors affected the yield and morphology of the nanopowders.

3. PRIMARY OBJECTIVES

Study the effects of varying F/O ratios and Fe₂O₃ morphologies on the combustion properties of Al-Fe₂O₃ nanothermite system.

4. EXPERIMENTAL STEPS

1st
Synthesis of Fe₂O₃

2nd
Coating Fe₂O₃ with P4VP

3rd
Mix and Ultrasonic coated Fe₂O₃ with Al

Final Product

Self-assembled Al-Fe₂O₃

5. RESULTS & DISCUSSION

Advantages of using Fe₂O₃ hollow nanospheres:
1. High specific surface area
2. High yield

Project Title: Synthesis and Characterization of Nanothermite System
Supervisor: A/P Hng Huey Hoon
Mentor: Cheng Jialiang

WHY choose pseudocubic Fe₂O₃?
1. Uniform size & shape distribution
2. Only one precursor is required
3. Suitable for mass production

6. FUTURE WORK

Compare the combustion properties of self-assembled Al-Fe₂O₃ nanothermite system that uses hollow nanospheres Fe₂O₃ with one that uses pseudocubic Fe₂O₃.

Effects of Fe₂O₃ morphologies at stoichiometric F/O ratio

<table>
<thead>
<tr>
<th>Sample</th>
<th>Method</th>
<th>F/O Ratio</th>
<th>Exothermic Peaks (DSC)</th>
<th>Energy Release Rate (Dynamic Pressure)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A*</td>
<td>Self-assembled</td>
<td>1.0</td>
<td>685.8°C</td>
<td>6.403kPa/ms</td>
</tr>
<tr>
<td>B</td>
<td>Self-assembled</td>
<td>1.0</td>
<td>730.7°C</td>
<td>1.823kPa/ms</td>
</tr>
</tbody>
</table>

* Taken from literature reported by J. L. Cheng et al. [2]