

PhD call 2016

Novel Fabrication & Characterisation of Thermite Structures

Summary

The key aim of this research is to review, understand and develop new processing techniques for thermite products with potential applications relevant to Defence and Security areas.

Thermite is a well-established pyrotechnic composition used by civilian and military bodies as a source of sustained high temperature for welding, cutting, demolition and initiation applications. A thermite reaction occurs when a mixture of a metal powder (fuel) and a metal oxide powder (oxidiser) is ignited using a sufficient ignition source. The nature of the output is dictated by compositional and form factors and needs to be matched to the needs of the system.

Conventionally, thermite is used in powdered form or block form. A block is obtained by pressing the powdered composition; a process for which hazards are associated. A block structure may need to include an additional binder component for mechanical robustness; however the binder may result in a reduction of ignition and burn performance. Also, the configuration of a block structure is reliant upon the press tool for which manufacturing difficulties may exist.

For some requirements, a thermite block may need to burn in a variable manner. This would require a structure consisting of distinct layers of different thermite compositions formed by separate pressings. However, at each layer interface, the possibility of mechanical and/or ignition failure exists, thereby limiting use in applications requiring a high degree of performance reliability.

The fabrication of three-dimensional thermite structures by the novel methods of additive printing ('3D printing') and sintering (use of heat and pressure to enable the metal component to act as a binder) have potential to overcome the highlighted issues. Also, the availability of thermite based products of non-conventional form would provide even greater flexibility for their application. A PhD study is therefore required to investigate these subject matters.

Research Goals

Proposals are invited to address the research objectives detailed below:

- Practical Baseline Study

Complete a practical baseline characterisation study using a selection of thermites in the conventional powdered and pressed states. The chosen compositions should demonstrate a range of reaction characteristics and be suitable for forming three-dimensional structures by the processes of additive manufacturing and sintering. Ignition via low voltage electrical means is desirable.

Determine ignition and burn performance of formed structures as well as other relevant physical properties e.g. mechanical strength of blocks. Relate observations to compositional features and mechanical processing methods.

- Additive Manufacturing

Investigate the feasibility of fabricating three-dimensional structures of the chosen thermites via an additive manufacturing process. Consider formation of structures comprising layers of different thermites.

Determine ignition and burn performance of formed structures as well as other relevant physical properties e.g. mechanical strength. Relate observations to compositional features and mechanical processing methods.

- Sintering Process

Investigate the feasibility of fabricating three-dimensional structures of the chosen thermites via a sintering process.

Determine ignition and burn performance of formed structures as well as other relevant physical properties e.g. mechanical strength. Relate observations to compositional features and mechanical processing methods.

- Non-conventional Forms

Undertake a practical feasibility study into the formation and performance of some thermite based products of non-conventional form e.g. a change from traditional colours is one such non-conventional form of interest.

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- Application Testing

Undertake application testing of project fabricated products as directed by the Authority.

Key dates:

- Closing date for applications is August 26th 2016
- Funding decision by September 12th 2016
- The project to commence, ideally, before the end of October 2016

What we want

- A well-rounded, coherent programme of work that consists of a good balance of innovative and challenging practical research to provide the student with a good level of training as well as fulfilling the desired research objectives set by the technical sponsors.
- An academic institution with expertise in the processing, handling and characterisation of energetic materials as well as regular access to appropriate equipment and processing and test facilities. In addition, prior experience of research and testing of thermites in particular is highly desirable together with an understanding of their applicability to Defence and Security environments.
- Preferably a UK National postgraduate student.
- Active collaboration with SME's at Dstl and where possible, publication in the open scientific literature.
- Use of academia as a highly valued discussion partner to validate our thinking and research concepts.
- Video footage of ignition and burning trials.
- Regular progress reports and review meetings.

What we do not want

- A highly theoretical and insular research study.
- Duplication of work already reported in the open literature.

Exploitation

A PhD programme of research will deliver valuable information for the smart application of termites in Defence and Security environments. Results and key outputs are expected to feed into various research programmes across Dstl and the MoD (UK).

Assessment criteria

PhD proposals will be reviewed under the following assessment criteria and all applications must provide the necessary information requested in the application form.

Assessment criteria used to evaluate the proposal

All applications will be evaluated for technical relevance and quality, prior to being considered further according to the academic/research groups or research centre and linkages criteria.

Assessment Area	Assessment criteria used to evaluate the proposal
<p>Scientific quality and innovation</p>	<ul style="list-style-type: none"> • The novelty and relevance of the proposed work in relation to the context. • Whether the proposed work is ambitious, adventurous, and transformative. • The pathway to impact for the proposed research. • How complete and realistic the proposed approach is.
<p>Academic staff, resources and management</p>	<ul style="list-style-type: none"> • Whether the Principal Investigator's/supervisor's and team's expertise aligns with the topic of the call. • The balance of skills in the team. • The time and commitment proposed. • If requirement for government furnished equipment or information (GFE, GFI) is realistic.

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Assessment criteria used to evaluate the academic/research groups or research centre and the value to Dstl.

Only technically strong proposals will be considered for funding. The academic/research groups or research centre and linkages criteria will be used to further assess the quality of the application(s).

Assessment Area	Assessment criteria used to evaluate the proposal
Academic/Research Groups or Research Centre	<ul style="list-style-type: none">• The evidence provided of the international standing of the research of the group or centre, including evidence of significant research income and their contribution to the UK and international research landscape.• The benefit MOD would obtain through funding research at the particular institution.• The benefits to MOD associated with any wider linkages.
Linkages	<ul style="list-style-type: none">• Other MoD projects/programmes within Dstl or Other Government Departments (OGD's)• Linkages within Defence Industrial Partners• If applicable, International Research Collaborators

Further Information and the process

The deadline for applications is the **29th August 2016**. Successful applicants will be informed week commencing **Monday 12th September 2016**. The project will need to commence, ideally, by the end of **October 2016**. Further terms and conditions will be made available, on request.