

**POLITECHNIKA ŚLĄSKA**  
**WYDZIAŁ CHEMICZNY**  
**KATEDRA FIZYKOCHEMII I TECHNOLOGII POLIMERÓW**

mgr inż. Mateusz Polis  
Dyscyplina naukowa: Nauki chemiczne

## **Rozprawa doktorska**

Hybrydowe nanotermyty (NSTEX) jako środki inicjowania specjalnego przeznaczenia

Hybrid nanothermites (NSTEX) as special purpose initiators

Promotor: dr hab. inż Agnieszka Stolarczyk profesor Politechniki Śląskiej

Opiekun ze strony zakładu: dr Barbara Lisiecka

**GLIWICE, 2024**

## ABSTRACT TO DOCTORAL DISSERTATION

### Hybrydowe nanoterminy (NSTEX) jako środki inicjowania specjalnego przeznaczenia

#### Hybrid nanothermites (NSTEX) as special purpose initiators

Mateusz Polis, M. Eng.

Supervisor: Agnieszka Stolarczyk, prof.

Supervisor from the company's side: Barbara Lisiecka, Ph. D.

The subject of this doctoral dissertation was the verification of potential application of hybrid nanothermite compositions in special applications and the development and fabrication of an initiating device. The unique properties of both, nanothermite compositions and based on them hybrid compositions, give an opportunity to predict their usefulness in such solutions. At the same time, there is a strong market demand to develop exceptionally precise initiator devices. This need is driven by the requirements to ensure adequate parameters regarding both the triggering time itself and its controllability, operating parameters, as well as the call for the highest possible level of safety in the production and use of initiation devices.

This goal was achieved through a series of R&D activities. In the first step, a review of the current state of knowledge was conducted, with a particular focus on existing research gaps. Secondly, the compositions' preparation path and parameters of the production process were established. Research was carried out for a number of nanothermite compositions with special reference to the mechanism of the high-energy reactions of these systems, their potential application and the possibility of further development under PhD thesis realisation. Subsequent researches were aimed at the selection of a suitable high-energy additive and characterization of the based on the chosen additive hybrid compositions, with a following series of tests designed to verify correctness of the high-energy additive selection.

Simultaneously with the cycle of research focused on scientific activity, a number of implementation - related works have been performed. These activities, results in the development of a system for measurement the sensitivity of high-energy materials to radiation irradiation, which the solutions developed during development became the basis for patent and utility model applications as well.

An initiating device impacting with an ignition stimulus, utilizing the developed NSTEX composition has been designed and fabricated, which enabled the preparation and filing of a

related patent application. The tunable ignition time of the initiating device, high performance parameters, ability to ignite the secondary charge which were an aerosol-forming pyrotechnic composition and solid heterogeneous rocket fuel have been demonstrated.

The completed scientific and implementation activities confirmed the legitimacy of the proposed hypothesis, and positively verified the possibility of using NSTEX compositions in initiation systems.