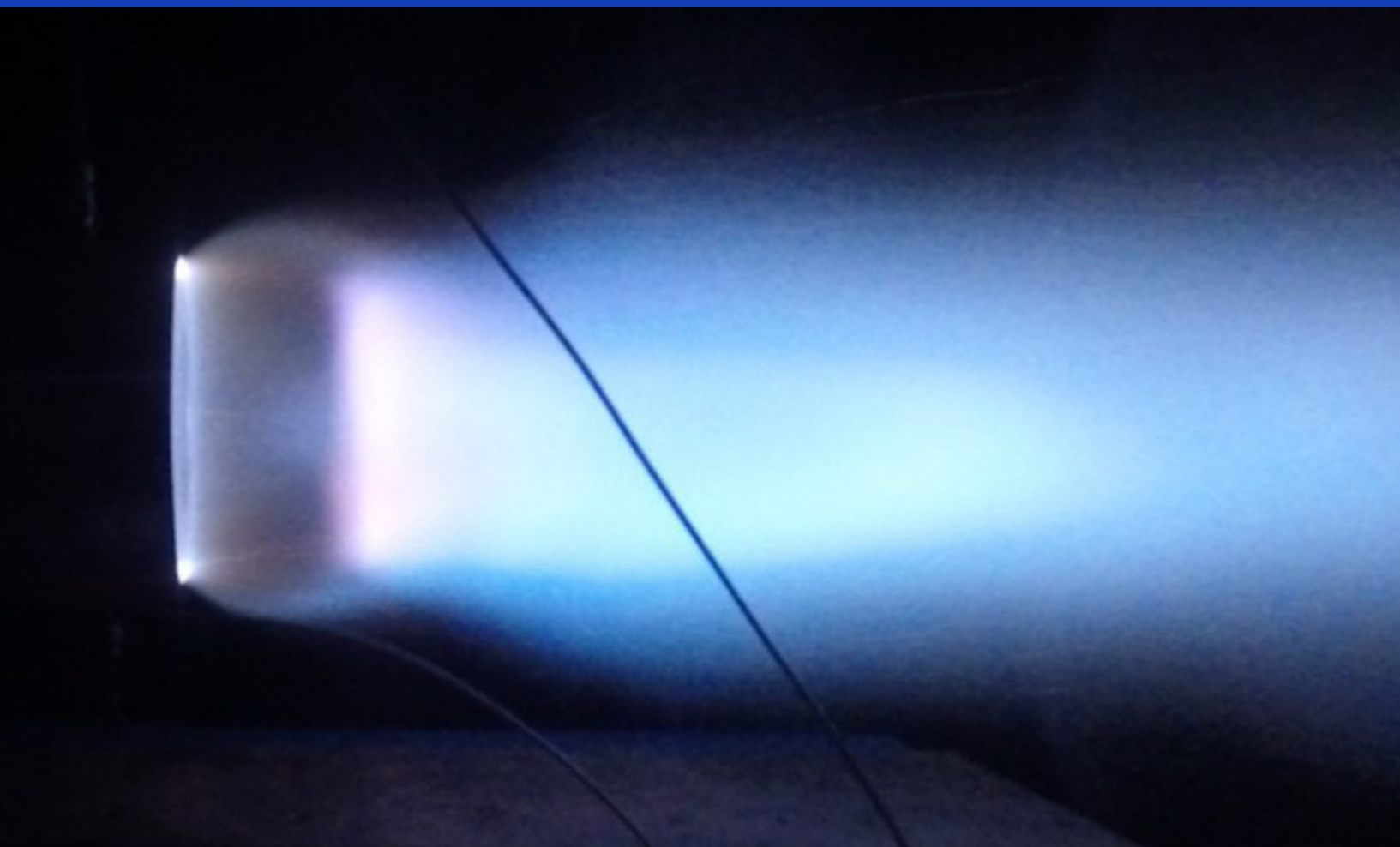


Aerospace Propulsion



From green propellants to detonation engines

Aerospace Propulsion is a product team within TNO's Energetic Materials department. Our multidisciplinary team develops and tests space propulsion, pyrotechnic products and new engine concepts, including hypersonic rocket testing and rotating detonation engines. We support governments and the aerospace and defence industry with affordable, sustainable technology that meets changing regulations.

Facilities and experience

The Energetic Materials department has laboratories, test benches and bunkers for rocket engine firings and (gas) explosions, built for the synthesis, analysis and handling of energetic materials. Over decades of work with combustible, explosive and toxic materials, such as pyrotechnics, peroxides, rocket propellants and flammable gases, solids and liquids, we have built unique expertise and a strong safety record.

From requirements to verified solutions

Our strength is deep knowledge of energetic materials and testing. We cover the full process: literature research, prototyping, proof of principle and product development. Give us a set of requirements, and we turn them into solutions that we then verify by modelling and testing.

Hypersonic rocket testing

Hypersonic flight, above Mach 5, puts extreme demands on propulsion, materials and thermal protection. We test rocket motors and components for hypersonic applications in our own firing facilities, under realistic conditions. We measure performance, combustion behaviour and the response of materials to heat and pressure, and we use the results to validate models. This helps clients move from design to a flight-ready system with fewer iterations.

Rotating detonation engines

In a rotating detonation engine (RDE), detonation waves travel continuously around a ring-shaped combustion chamber. Compared with conventional engines, this promises higher efficiency in a more compact design, for both rocket and air-breathing propulsion. We combine our detonation expertise with modelling and hot-fire testing to develop and characterize RDE concepts, from chamber design to stable operation. This work supports the next generation of European engines.

Case study: ExoMars parachute mortar

TNO joined the team building the parachute mortar for ESA's ExoMars mission. Based on the client's specifications for firing profile and speed, ageing, and shock and vibration loads, we selected and verified a propellant that met all requirements. We also proposed key design changes to the mortar gas generator. It is the first parachute system of this kind developed in Europe in decades.

Innovating igniters

Hybrid igniters combine a solid fuel with a liquid oxidizer. They avoid the unstoppable burning of solid propellants, as well as the complexity of two propellant feed systems and a separate initiator. A catalyst decomposes the liquid oxidizer and ignites the solid fuel core. This makes the igniter inherently safe and insensitive to cracks in the fuel.

Case study: 3D-printed catalyst bed

We developed a new catalyst bed for a monopropellant rocket igniter. Using in-house modelling and 3D printing, we designed a bed that is more predictable, more reproducible and more efficient: counter flow spreads the heat better through the propellant.

Cool gas generators

Cool gas generators are a showpiece of our team. TNO acquired the patent and developed the technology into a micro-propulsion technique. When decomposed, a solid grain releases pure gas at ambient temperature, so no high-pressure gas storage is needed during the product's life. We make them for nitrogen and oxygen, and are developing them for hydrogen, carbon dioxide and methane. Uses include inflatables, emergency oxygen and propulsion.

Case study: propulsion for small satellites

Small satellites such as CubeSats often share a launch with larger ones, and may not carry pressurized systems. In a cool gas generator the gas is chemically bound in a solid, so it meets these rules while still providing gas in space. With other TNO departments, we develop complete propulsion systems, from the gas-producing solid to the micro-thrusters.

Green propellants

The EU REACH regulation aims to reduce the use of hazardous chemicals, while rocket launches and commercial space flight keep growing. Hydrazine, the standard propellant for in-space propulsion, is listed as a substance of very high concern. We develop alternatives that protect health and the environment and keep Europe competitive. For example, we designed an ethanol-based fuel with additives that is hypergolic with hydrogen peroxide at atmospheric conditions, and tested it in our facility.

What you get

Clients from SMEs to multinationals and governments value our rapid response and independence. Every project ends with results and a thorough interpretation: what does this mean for your business?

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