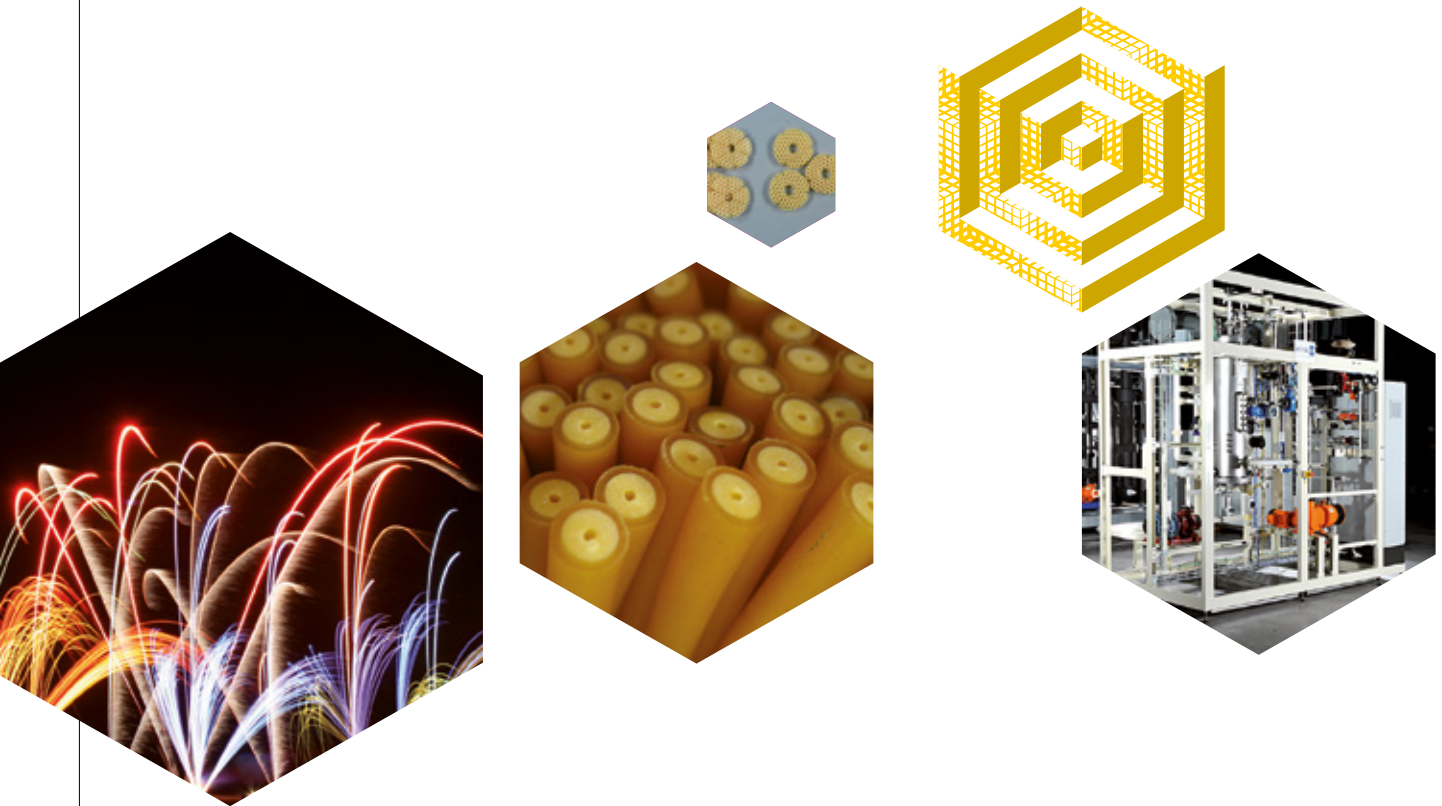


# PROPELLANTS, PROCESSING AND PYROTECHNICS



**TNO** innovation  
for life

Propellants, Processing and Pyrotechnics (3P) is a product team within TNO's Energetic Materials department. The multi-disciplinary 3P team is specialized in process innovation and customized product modelling, development and testing. It has all the necessary resources and qualifications to assist governments as well as companies in the chemical and defense industry. The high-quality results will enable your organization to innovate in the field of propellants and pyrotechnics.

The facilities of the Energetic Materials (EM) department, which include test banks, laboratories and bunkers for (gas) explosions, are designed for the synthesis, analysis and handling of energetic materials. In the decades of experience working with explosive and toxic materials such as pyrotechnics, organic peroxides, ammonium nitrate fertilizers, self-reactive and self-heating substances and flammable gases, solids and liquids, the EM-department built a considerable expertise while maintaining a safe track record. Its global customer base, ranging from SMEs to multinationals and governments, values the rapid response, independence and effort to go that extra mile. After every project, you will receive the results and findings, including a thorough interpretation and analysis. In this report, the EM team will never lose track of that one question: what does this actually mean for your business?

## PROPELLANTS: TOWARDS CUSTOMIZATION

Because the industry is always asking for better products, the 3P team stays at the forefront of propellant development. For example, they have pioneered and developed continuous extrusion as a production method for gun propellants. Continuous extrusion has benefits over batch production by ram extrusion. First of all, it is intrinsically safer, as smaller amounts of material are processed at any time. But it also allows for better fine-tuning of the process, leading to a higher-quality, more standardized product. The 3P team's expertise in continuous extrusion becomes especially visible in their successful development of a solventless propellant process, resulting in more environmentally friendly products.

**Case study:** The 3P team developed co-extrusion. This process provides even more versatility, allowing for propellants with a coating. Coatings can, for example, make the propellant perform more consistently over a large range of ambient temperatures, or render the resulting gases less corrosive. Or it can lower the temperature of these gases, which also reduces their corrosiveness, in turn increasing the longevity of the barrel. The 3P team applies their in-house modelling skills to do everything from designing a propellant for the desired pressure curve to the optimization of the ingredients and mixing.

**PROCESSING: INNOVATION**

Innovation in the application of energetic materials goes hand in hand with newer and more advanced production processes. Therefore, one of 3P's focal points is 3D printing—a hot topic in society, but not readily available for energetic materials. The 3P team is changing this, and here it becomes clear that the Energetic Materials department is embedded in the larger context of TNO, where many disciplines are available to draw from. Learning from their 3D-printing colleagues, the experts at 3P started to adapt the process for energetic materials. For example, they created new print heads that measure temperature and pressure for safety monitoring. In general, gaining understanding of this production process allows 3P to develop an enabling technology for future ammunition with more customization and a better sustainability profile.

**Case study:** The 3D printing of gun and rocket propellants is an exciting development, because the freedom in shaping means that most restrictions have fallen away. The 3P team is exploring this, and already prints propellants for use—in fact, TNO is the first in the world to fire a gun using a 3D-printed propellant. Yet the team keeps improving, and they are now aiming for propellants with variable characteristics. By changing the composition of the ingredients while the printing process is running, 3P opens the door to extensive customization of the performance of the propellant. For example, it is possible to create a missile that starts with a high speed, then tapers off to a lower cruising speed and ends with an acceleration towards the target.

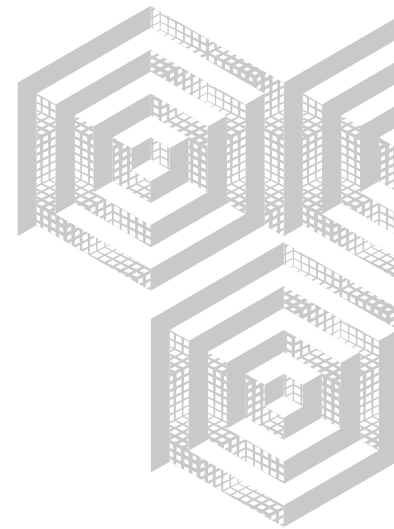
**PROCESSING: CONTROL**

Besides the demand for more innovative propellants and ammunition, there are more reasons why the 3P team works to improve production processes. The change from batch processing to continuous production, for example, allows for much more control, making it easier to develop unique, high-quality products at the desired quantity. Additionally, it is safer and it requires less overhead to maintain around-the-clock production.

**Case study:** The production, transport and storage of NG, an additive in gun propellants, is currently quite expensive because of special safety requirements. However, if this material is produced on-demand and on-site by adding it to the production of gun propellant, there is no need for intermediate transport or storage. This generally drives down costs and opens the door for safer and more sustainable options. To help clients with the transition towards on-demand production of NG, the 3P team developed Modular Autonomous Production Systems, or MAPS. Ask the 3P experts about them and start innovating!

**PYROTECHNICS**

**Case study:** Even in a technology as old as fireworks, the 3P team can create innovation. One client in this industry wanted to have a smaller impact on the environment by using more sustainable fireworks. In a case like this, the experts at 3P can use their knowledge about the entire range of energetic materials. They thought outside the box and came up with a new type of pyrotechnic composition. It burns much cleaner, so that only a fraction of the heavy metals is needed to create the vibrant colors that the firework displays are known for.



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**DEFENCE, SAFETY AND SECURITY**

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