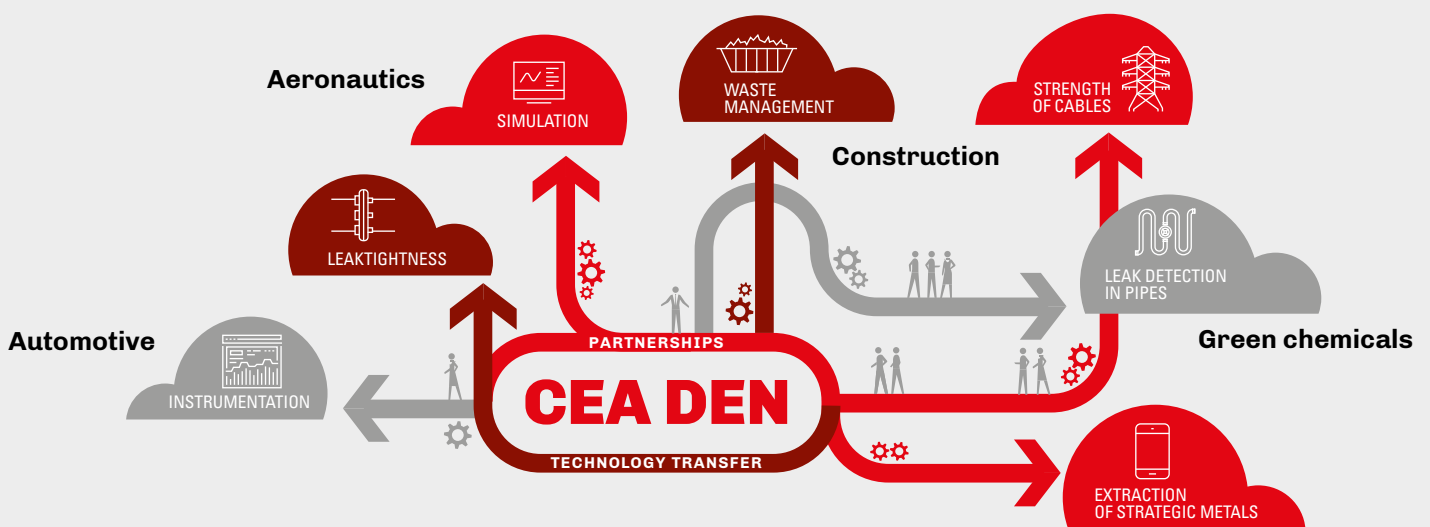


TECHNOLOGY TRANSFER



Promoting research
by the Nuclear Energy Division of CEA

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> The creation of start-ups and spin-offs

The French Atomic Energy and Alternative Energies Commission (CEA) employs 16,000 people and is the French leader in research, filing hundreds of patents every year (684 in 2017¹); it has partnerships with more than 500 small and intermediate sized enterprises and industries, guaranteeing the transfer of its expertise and techniques to the French industry.

It is in this context that the Nuclear Energy Division (DEN) supports the creation of start-ups and spin-offs in various sectors outside the nuclear industry, such as nano-materials, green chemicals, and advanced factories of the future. Through partnerships with the DEN, the French industry is able to benefit from the skills, know-how, technologies and techniques developed by the CEA.

The DEN boasts a portfolio of 559 active patents (2017) that are behind a range of services, R&D agreements and license transfers on various different technology bricks that the DEN has decided to promote outside the nuclear sector to support the industry in general.

There are two DEN entities that clearly reflect this approach: a laboratory called Maestral shared with Technetics Group France which is specialised in seals and employs 12 people, and a laboratory called Labra offering irradiation services exclusively for the industry.

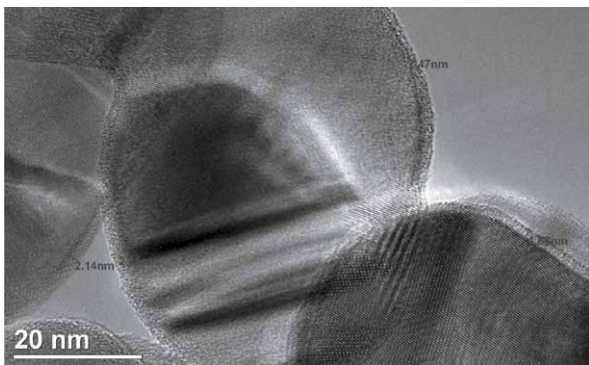
This initiative to promote CEA research goes as far as supporting the inception of spin-offs and start-ups exploiting DEN technologies.

(1) <https://www.inpi.fr/fr/nationales/palmares-deposants-brevets-2017-France>

➤ Start-ups and spin-offs with strong ties to the DEN



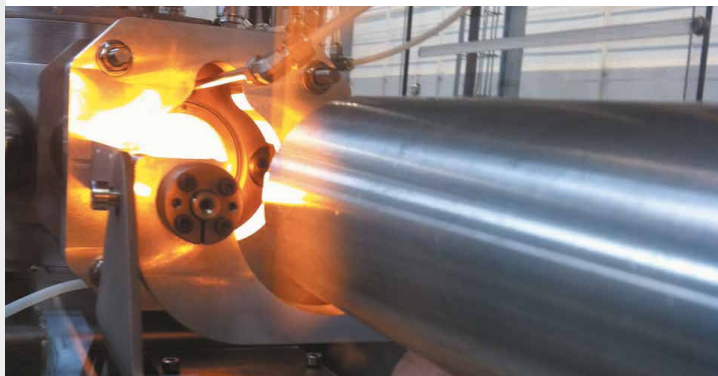
Improving the characteristics of materials using nanoparticles



Nanomakers designs, manufactures and sells patented silicon-based nanopowders that improve the inherent properties of materials by disruption and that can double the energy density of anode materials in Li-ion batteries.

This DEN spin-off was created in 2010 as a start-up to market a novel technology developed in one of its laboratories specialised in extreme materials. Nanomakers has since grown and expanded its field of activity to include other applications such as semiconductors, energy storage and reinforcement of innovative materials for the nuclear industry. For instance, it has deployed a process based on the sintering of nano-particles to obtain high-density parts designed to contain nuclear fuels. It is also pursuing new R&D projects (products and applications) in collaboration with the CEA which is still a shareholder. Nanomakers generated sales exceeding €1.8 million in 2017 and currently employs 12 people.

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Eco-efficient cleaning using supercritical CO₂

The start-up called Dense Fluid Degreasing (DFD) was set up in 2012 to market a technology harnessing CO₂ to clean mechanical parts and polymer textiles, thus providing an alternative to polluting processes using water and/or chemicals. Based in Bourget-du-Lac (France), DFD is gradually gaining ground in the industrial cleaning sector.

Its machines use supercritical CO₂ which removes grease from complex parts when combined with stirring and ultrasounds, without requiring any water and therefore not oxidising them; this technique produces excellent results in terms of particle removal and greatly reduces the microbial load. This process helps improve cleanliness levels while reducing operational costs; it uses half as much electricity, can be operated continuously with no maintenance requirements, recycles oil, protects the environment, poses no health risks, and can be used on complex-shaped parts. It has even made it possible to reduce cleaning times by a factor of 2 to 3 in the medical industry.

The DFD-MC 4.1 machine was eco-designed and developed in collaboration with the Technical Centre for Mechanical Industry (CETIM-CTDEC) based on a CEA patent, making it the first cleaning machine to operate with supercritical CO₂ in industrial premises. This machine was awarded the innovation trophy in the eco-efficiency category at the Lyon industry show in April 2017. DFD posted revenues worth €340 k in 2017 and currently employs 7 people.

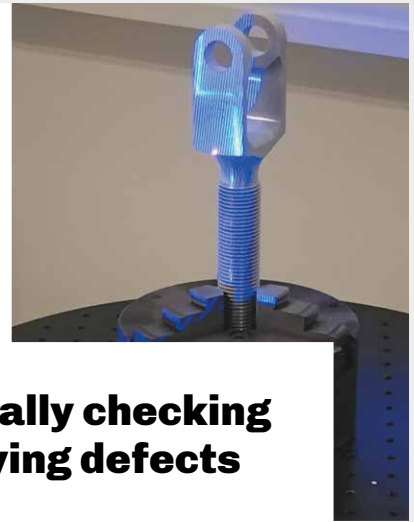
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Treating and recycling industrial waste and effluents

The start-up called Extracthive was set up in 2015 with the objective of transferring CEA know-how in treating complex waste to the industry. This company develops technologies to treat and recycle raw materials contained in industrial waste and/or effluents. Largely based on the CEA DEN existing model, Extracthive is in a position to offer a recycling solution applicable in industrial contexts.

In 2017, Extracthive also set itself the goal of becoming a key player in industrial recycling by buying two sites for the deployment - within 3 years - of two technologies to recycle worn abrasive materials and carbon-fibre materials. To date, the company has generated sales of €3.7 million and employs more than 35 people.

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Automatically checking and rectifying defects in parts

Innovative Manufacturing & Controls (I-MC) is the name of a start-up created in November 2017. It is developing a novel robotic solution for numerically controlled machines, thus championing an ambitious industrial project in the context of the *Usine du futur* and *French Fab* initiatives.

The I-MC innovation is capable of quickly and precisely checking a part on a machine without having to disassemble it, i.e. in situ inspection. It can also deal with defects directly next to the machine. This technical breakthrough will significantly reduce the time and the stages between design, methods engineering, manufacturing and inspection. On the basis of performance criteria defined by the supervisor program (acceptability of a dimension, type of defect, etc.), the I-MC solution provides operators with inspection and/or manufacturing defect correction functions. I-MC was created in 2017 and currently employs 4 people. It was created by Dominique Nozais and Stéphane Robic together with five other partners including the CEA and the École Centrale de Nantes.

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Performing automatic *in situ* analysis in harsh environments



Iumtek is a cleantech 'innovation' start-up that was created in October 2017 to focus on industrial-scale optical instruments operating in harsh environments. It designs and manufactures instruments for the real-time *in situ* analysis of materials based on a laser-induced breakdown spectroscopy (LIBS) technology derived from research by the CEA and Orano over the past 20 years. It is targeting the sectors of nuclear dismantling, industrial processes, and detection of nano-particles in industrial processes and stack effluents.

LIBS is a real-time method used for the elementary analysis of all types of materials through the emission of a laser beam. It requires no prior preparation of the material regardless of its state (liquid, solid or gas).

The interactions between the light and the material provide qualitative and/or quantitative data on the material. The ergonomic, intuitive user interface and the automatic data acquisition system for the Iumtek instrument are designed to ensure safe operation at all times.

Supported by CEA Investissement, Iumtek collaborates with the scientific and valorisation team at the DEN (Saclay) and its industrial partners through both an R&D framework agreement and an exclusive right to use its patents on the LIBS technology. Iumtek generated sales of €30 k during its first two months of business in 2017 and currently employs 4 people.

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