Project profile

Cluster for Application and Technology Research in Europe on NanoElectronics

# CA402 | Striking technologies for power [THOR]

**PROJECT CONTRIBUTES TO**

| | |
|---|---|
| Communication | |
| Automotive and transport | ✔ |
| Health and aging society | ✔ |
| Safety and security | ✔ |
| Energy efficiency | ✔ |
| Digital lifestyle | |
| Design technology | ✔ |
| Sensors and actuators | |
| Process development | |
| Manufacturing science | |
| More than Moore | |
| More Moore | |
| Technology node | |

**HEALTHCARE DEVICES AND SYSTEMS**

**Partners:**

Ampere INSA Lyon
AVX/TPC
BATSCAP
Bruco
CIRTEM
EADS
Epsilon Ingénerie
HCM
HISPANO-Suiza
NXP
Philips Healthcare
Prodrive
Soitec
STMicorelectronics
Uni Technology Eindhoven
Uni Versailles-Saint-Quentin-en-Yvelines
Valeo

**Project leader:**

Mark van Helvoort
Philips Healthcare

**Key project dates:**

Start: October 2010
End: September 2013

**Countries involved:**

Belgium
France
The Netherlands

The CATRENE THOR project is developing highly efficient, integrated and reliable power electronics technologies offering new applications and increasing the competitiveness of major European industries in automotive, aeronautics and healthcare applications. The project aims to exploit new technologies for discrete power components, power cores and storage elements – currently one of the most promising areas of electronics – while improving the robustness and reliability of high power electronics systems and facilitating their miniaturisation. Success in this project will allow new applications and offer major benefits to European industry from power electronics components to complete systems.

Power electronics play an important role in automotive, transport, energy, medical and industrial applications with converging interests between 200 V and 3 kV. Energy saving is increasingly important with a strong demand for electrical applications yet limited ecological resources. This calls for rapid advances in power semiconductor device, module and storage technologies. There is considerable pressure on all industries to innovate at systems, device, technology and manufacturing levels.

Moreover, while silicon technology has performed well in power electronics, it has virtually reached its limits in terms of switching frequency, operational temperature and voltage blocking. The current generation of power electronics used in high voltage inverters and boost converters in hybrid electric vehicles is based on a combination of insulated gate bipolar transistors (IGBTs) and silicon carbide (SiC) Schottky diodes. Given the large power levels – more than 30 kW – involved, complex packaging and cooling are necessary.

Wide band gap semiconductors – substrate materials with electronic band gaps greater than 1 or 2 eV – offer major advantages in such high temperature applications as they can function at over 150°C without external cooling. The resulting electrical efficiency improvement is a key driver for their adoption. However their wide-scale industrial application has been hampered by missing elements in the value chain and a fragmented market which has prevented sufficiently consistent investment in materials development.

## Cutting development costs

The CATRENE CA402 THOR project is therefore bringing together three application domains to create economies of scale and apply the resulting leverage to the design of common power technology. This novel technology will be based on wide band-gap materials which are more heat resistant and hence more compact, leading to increased applicability and integrally lower cost.

Automotive, aeronautics and healthcare end-users, chipmakers and capacitor manufacturers will work together with technology developers and European academic partners in this major project co-labelled with the EUREKA EURIPIDES Cluster.

THOR aims to develop highly efficient, integrated and reliable power electronics technologies for automotive, aeronautics and healthcare applications – particularly magnetic resonance imaging systems where smart power management could ensure energy is only consumed when really needed. Crucial will be the development of high power transistor and diode switches based on innovative silicon process, silicon on insulator (SOI) or wide band gap materials such as SiC or gallium nitride (GaN).

The CATRENE project will develop new technologies for discrete power components – such as IGBTs, junction gate field effect transistor (JFETs) and diodes – based on wide band gap semiconductors as well as power cores and super-capacitor storage elements. THOR will also develop innovative and affordable packaging for high temperature, thermal and electromagnetic compatibility (EMC) management solutions.

Key outcomes will be reliability design oriented prototypes of:

- Miniaturised high voltage, high frequency and high temperature power modules based on new SiC or GaN wide band gap semiconductors, advanced IGBTs and silicon diodes, and high temperature SOI or SiC drivers; and
- DC-to-DC converters using improved silicon-based power devices.

In addition to wide band gap technologies, a revolutionary new silicon IGBT technology concept for high speed switching with nearly loss-free, on-state characteristics will be investigated.

## Innovative power devices

THOR will focus on application areas which favour an innovative European power electronics industry. This will involve the development of highly efficient, low weight and compact power modules for ubiquitous products such as power converters and functional electrical energy storage with superior performance.

Facing up to the global environmental challenge in terms of $CO_2$ emission and over reliance on fossil fuels calls for approaches favouring electricity as the sole source of energy harvesting, transport and storage. In the automotive sector, the fast growing demand for electric vehicles calls for economical, efficient and low cost solutions based on new packaging and innovative components to extend driving range – requiring safe and reliable storage solutions.

Aeronautics need safe but highly integrated and lightweight power electronic systems, such as DC-to-DC or AC-to-DC converters and inverters, built from several individual power modules. High voltage devices would significantly reduce the sections of the several km of copper cables found in a single aircraft, thus saving weight; 30% of power could also be saved by transient storage of energy during braking.

And in the medical area, power electronics determine more than half of the total cost of ownership of diagnostic imaging systems such as magnetic resonance imaging scanners. More efficient and compact components are essential with reduced packaging and lower costs.

Overall objectives include:

- Demonstrating high performance power electronics systems with SiC, GaN and SOI components;
- Developing 20% more energy-efficient automotive power semiconductor technologies;
- Performing reliability oriented design of architectures, sensors and integrated drivers and components;
- Reducing EMC emission through development of EMC filters;
- Developing thermal management systems involving both components and packaging;
- Defining a scalable platform concept for automotive power modules; and
- Harmonising high-voltage safety concepts for components and vehicles.

## Boosting competitiveness

Improving the robustness and reliability of high power electronics systems, facilitating their miniaturisation and reducing their cost will allow for new applications in the automotive, transport and healthcare sectors and will increase the competitiveness of the major European industries in these fields.

Success in this CATRENE project will also provide a boost for European industry in the area of power electronics and storage components – currently one of the most promising areas of electronics. THOR will contribute to sustaining a competitive situation for the European automotive industry, to speed up the time-to-market and to improve the cost factor for the end-users by enabling the development of standardised power components, dedicated modules and low consumption subsystems for electric vehicles.

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**CATRENE** (Σ! 4140), the EUREKA **C**luster for **A**pplication and **T**echnology **R**esearch in **E**urope on **N**ano**E**lectronics, will bring about technological leadership for a competitive European information and communications technology industry.

**CATRENE** focuses on delivering nano-/microelectronic solutions that respond to the needs of society at large, improving the economic prosperity of Europe and reinforcing the ability of its industry to be at the forefront of the global competition.