CALL 2010

Project profile

NanoTEG

Nanostructured thermoelectric systems for green transport and energy efficient applications

The primary objective of the ENIAC JU project NanoTEG is to resolve crucial cooling and energy-management issues in current transport applications. NanoTEG will take advantage of the technical improvements offered by highly-efficient, nanostructured, thermoelectric modules that are compatible with high-volume manufacturing processes to develop and produce relevant industrial demonstrators integrating innovative and efficient cooling systems. The successful outcome of NanoTEG will have a strong impact on global automotive and avionics markets. It will also benefit European society as a whole.

Sub Programme

- Nanoelectronics for automotive and transport
- Nanoelectronics for energy efficiency

Solid-state thermoelectric devices have many attractive features compared with other cooling and heat control technologies. They have no moving parts and emit no toxic gases, while offering long lifetime, low maintenance and high reliability. Their energy-conversion efficiency is measured in terms of the ZT figure. Theoretical investigations reveal no maximum ZT limit from a physical standpoint.

Inexpensive and highly-efficient thermoelectric devices could revolutionise the cooling industry. In particular, the efficient removal of heat from nanoelectronics circuits would considerably improve the lifetime and reliability of all semiconductor devices, including CMOS-based microprocessors, memories, logic and analogue integrated circuits, optoelectronic devices, sensors and actuators, and power transistors.

Conversely, if heat could be converted to electricity, high ZT thermoelectric devices could take advantage of the waste heat generated in internal combustion engines to make cars more energy efficient. Consequently, thermoelectric devices will enable a more efficient use of energy, producing a considerable economic benefit and ensuring a societal advantage for sustainable development.

Two types of functionality

The core purpose of the ENIAC JU project NanoTEG is to demonstrate the efficiency of nanostructured thermoelectric devices targeting on-chip electronic cooling systems and thermo-power generation systems. Both functionalities have the potential to induce a marked reduction in electrical consumption by playing a key role in the cooling chain or by optimising the energy consumption of autonomous systems.

NanoTEG will develop two technical pillars:

1. Nanostructured thermoelectric materials which are highly efficient and compatible with existing high-volume fabrication processes; and

2. Innovative packaging solutions, allowing the integration of nano-thermoelectric materials into highly efficient modules at the core of system-level demonstrators for the automotive and avionics industries.

Targeting key gaps

These demonstrators will target the key gaps in the development of basic power and power-management technologies needed in the short to medium term. The expected results will contribute to the key competences needed in nanoelectronics to ensure global European competitiveness.

Existing cooling techniques for on-board avionics and aircraft control equipment are not compatible with the heat flux foreseen for the next generation of aircraft. The problem is exacerbated if cooling is lost but the equipment must survive 30 minutes at 70°C. Thermal-management issues are the most critical challenge in the design of electronic devices. While the International Technology Roadmap for Semiconductors indicates that heat dissipation from a single-chip package is expected to reach between 120 and 220 W, current air-cooling technologies are approaching capacity.

The electrical loads of today's electrical power-hungry motor vehicles are related to multimedia, heating, ventilation and air conditioning, body electronics – such as power windows and heated rear windows – and both interior and exterior lighting; their total consumption can exceed 3 kW.

A conventional vehicle, with an internal combustion engine, uses part of its driving force – about 5 kW – to power all this equipment through the alternator with an efficiency of approximately 60%. Such a vehicle is characterised by an abundance of wasted heat – about 70% of the energy derived from the fuel – which is used to warm the vehicle interior during winter, while an air-conditioning unit provides climate control during summer with a power load of 2.3 kW. This inevitably causes a considerable increase in fuel consumption, CO_2 and pollutant emissions, weight and system complexity.

In a fully electric vehicle, electrical auxiliaries are supplied by the battery pack, resulting in a substantial installed mass to ensure a reasonable 50 to 100 km driving range. The power consumption of any kind of auxiliary equipment contributes to a reduction of that driving range and decreases battery life.

Massive opportunity

For all of these applications, specific solutions have to be identified and adopted to provide advantages as well as limiting risks to the health and comfort of people. The strengths of European innovators in embedded systems design, nanoelectronics and systems integration must be urgently exploited to ensure a significant claim to the massive market that is set to emerge in the coming decades.

The successful completion of NanoTEG will, therefore, provide wide-ranging benefits not only to the European aviation and automotive sectors but also to European society as a whole.

Automotive and transport

Partners:
- Biometric Technology Solutions
- Catalan Institute of Nanotechnology
- CEA-LITEN
- Center for National Scientific Research (CNRS)
- Centro Ricerche Fiat
- CIDETE Ingenieros
- LEITAT Technological Center
- Micropelt
- NCSRD-IMEL
- PANCO
- Smart High Tech
- Thales Avionics
- Thales Research & Technology
- Uninova

Project co-ordinator:
- Afshin Ziaei, Thales Research & Technology

Key project dates:
- Start: July 2011
- Finish: June 2014

Countries involved:
- France
- Germany
- Greece
- Ireland
- Italy
- Portugal
- Spain
- Sweden

Total budget:
- €6.09 million

Details correct at time of print but subject to possible change. Updates will be included in the project summary at the end of the project.

The ENIAC Joint Undertaking, set up in February 2008, co-ordinates European nanoelectronics research activities through competitive calls for proposals. It takes public-private partnerships to the next level, bringing together the ENIAC member states, the European Commission and AENEAS, the association of R&D actors in this field, to foster growth and reinforce sustainable European competitiveness.

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