Advanced Research Projects Agency • ENERGY

FIRST OPEN SOLICITATION

DELPHI AUTOMOTIVE

MORE EFFICIENT POWER CONVERSION FOR EVs

PROJECT TITLE:	Gallium-Nitride Advanced Power Semiconductor and Packaging		
ORGANIZATION:	Delphi Automotive Systems, LLC (Delphi)	LOCATION:	Kokomo, IN
PROGRAM:	FOA1	ARPA-E AWARD:	$6,733,386
TECH TOPIC:	Vehicle Technologies	PROJECT TERM:	2/1/10 – 6/30/12
WEBSITE:	www.delphi.com		

CRITICAL NEED

All electrical and electronic devices—including hybrid electric vehicles (HEVs) and electric vehicles (EVs)—are built to operate with a certain type of electrical energy. Often, this is not the same type of electrical energy that comes out of your wall outlet or a generator on the vehicle, so electronic power converters are used to modify the electrical energy and create a useable current, voltage, and frequency for the vehicle's electric motor and other electrically powered devices. Within the next 20 years, 80% of the electricity used in the U.S. will flow through these power converters, so there is a critical need to improve their efficiency, reliability, size, and cost.

PROJECT INNOVATION + ADVANTAGES

6" GaN-on-Si Wafer → Packaging → Power Board

Delphi is developing power converters that are smaller and more energy efficient, reliable, and cost-effective than current power converters. Power converters rely on power transistors which act like a very precisely controlled on-off switch, controlling the electrical energy flowing through an electrical circuit. Most power transistors today use silicon (Si) semiconductors. However, Delphi is using semiconductors made with a thin layer of gallium-nitride (GaN) applied on top of the more conventional Si material. The GaN layer increases the energy efficiency of the power transistor and also enables the transistor to operate at much higher temperatures, voltages, and power-density levels compared to its Si counterpart. Delphi is packaging these high-performance GaN semiconductors with advanced electrical connections and a cooling system that extracts waste heat from both sides of the device to further increase the device's efficiency and allow more electrical current to flow through it. When combined with other electronic components on a circuit board, Delphi's GaN power transistor package will help improve the overall performance and cost-effectiveness of HEVs and EVs.

IMPACT

If successful, Delphi would improve the efficiency of power conversion by 50% or more—making a wide variety of HEVs and EVs more viable alternatives to conventional gasoline-powered vehicles.

- SECURITY: Increased use of EVs would decrease U.S. dependence on foreign oil—the transportation sector is the dominant source of this dependence.
- ENVIRONMENT: This project would help facilitate widespread adoption of energy-efficient HEVs and EVs, greatly improving local air quality in high-traffic urban and suburban areas while reducing greenhouse gas emissions.
- ECONOMY: HEVs and EVs could save the typical American driver $500 a year in fuel costs.
- JOBS: Jump-starting the U.S. HEV/EV industry would create jobs in manufacturing, engineering, sales, and supporting services.

CONTACTS

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Partner Organizations:
International Rectifier,
Oak Ridge National Laboratory