IMPACT

Digital services play an increasingly important role in our lives and the economy. Data centres are the backbone of the modern economy (e.g. server rooms in SMEs, data centres and server farms), as they provide services such as cloud computing, mobile apps and other digital applications. Therefore, GaNonCMOS aims to develop low cost and reliable integrated technologies and power electric systems, which have a broad range of voltages and very high energy efficiency to tackle energy efficiency in data centres. Moreover, the developed technologies and systems will have a voltage range that is meaningful for many other emerging energy intensive applications such as e-mobility, or traditional markets such as automotive, aviation, industrial applications.

The GaNonCMOS technology has the potential to significantly lower the annual energy usage of data centres in Europe. Also, in the other target sectors, such as (individual) e-mobility and aviation, a highly relevant reduction of energy consumption and CO_2 emission can be achieved. For example, due to energy efficient and lightweight VRMs developed in the GaNonCMOS project, a significant saving of airplane fuel is expected.

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GaN densely integrated with Si-CMOS for reliable, cost effective high frequency power delivery systems.

BACKGROUND

Over the next 15 years, the total energy consumption is projected to increase by 25 - 35% due to the elevation of a few billion people from poverty into the middle class, and the increasing world economic output. For instance, the explosion of digital content such as e-commerce, social media and big data is making data centres one of the fastest-growing consumers of electricity in developed countries.

ABOUT

The aim of the GaNonCMOS project is to develop novel low cost and reliable GaN-based process, components, modules and integration schemes, and demonstrate their performance and economic potential on system level for significant energy reduction in a wide range of energy intensive applications.

The key innovations steps are:

- Long term reliability improvements over the full value chain of materials, devices, modules and systems.
- Develop new soft magnetic core materials reaching switching frequencies up to 300 MHz with ultralow power losses to be integrated at different levels.
- New materials and methods for miniaturized packages to allow GaN devices, modules and systems to operate under maximum speed and energy efficiency.
- Integrate GaN power switches with CMOS drivers densely together using 3 different integration schemes from the package level up to the chip level using wafer-bonding between GaN on Si (111) and CMOS on Si (100) wafers.
- Optimize the GaN materials stack and device layout to enable fabrication of normally-off devices for such low temperature integration processes (max 400°C).

Data centres

Aviation

e-Mobility

GaNonCMOS

The development of beyond the state-of-the-art materials in devices, modules and systems in GaNonCMOS will drive a new generation of densely integrated power electronics and pave the way toward low cost, highly reliable systems for energy intensive applications. Three different routes to make voltage regulator modules (VRMs) with GaN power switches are shown below with an evolution of increasing integration and complexity level from the package level to the stack level and the way up to the chip level.