

The 1<sup>st</sup> Global COE International Symposium  
Satellite meeting “Recent activities of IDER units”

# Research Unit of the Concept for Next Generation Power Semiconductor Devices

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Jan. 18, 2008

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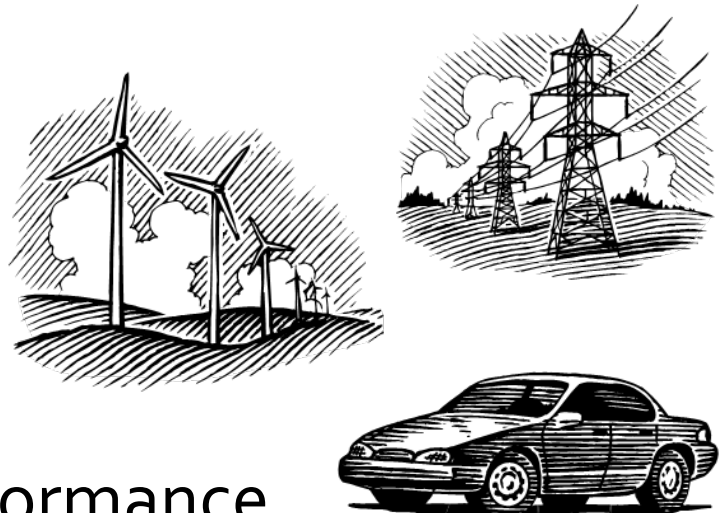
# Introduction

- **Power Electronics engineering** is one of the promising solutions for problems of energy saving and CO<sub>2</sub> reduction.

- Motor drives
- Power systems
- Distributed generations

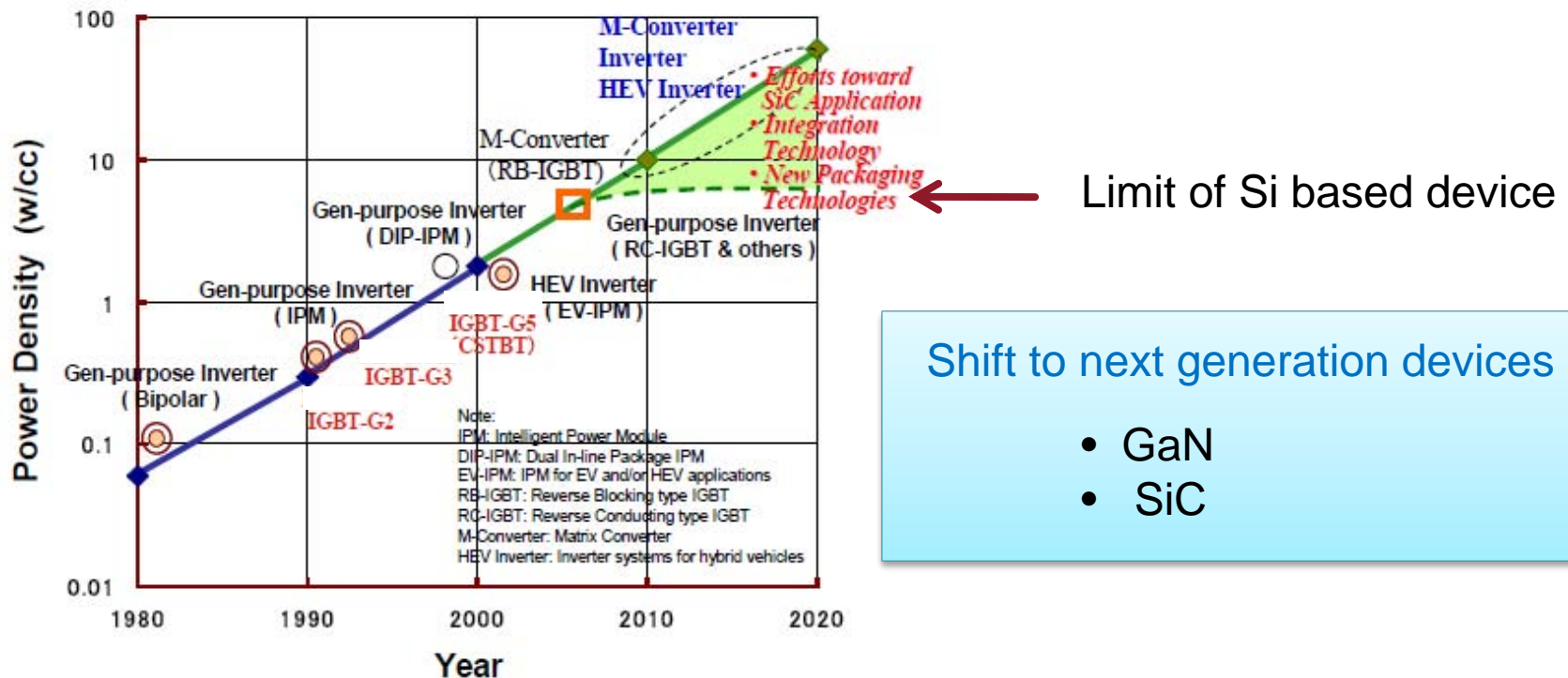


High efficiency, High performance



# Why next generation devices?

- Higher efficiency, lower volume  
 → Higher power density



G. Majumdar, "Power Modules As Key Component Group For Power Electronics," the Proceedings of PCC 2007, Nagoya.(c) 2007 IEEE)

# Advantages of wide band gap devices

- Higher voltage
- Higher frequency  $\Rightarrow$  smaller  $L$  and  $C$
- Higher operating temperature
- Lower losses  $\Rightarrow$  smaller cooling components
  - Conducting losses
  - Switching losses



Higher power density

	Bandgap (eV)	Breakdown strength (MV/cm)	Electron mobility (cm <sup>2</sup> /Vs)	Electron saturation velocity (x10 <sup>7</sup> cm/s)	Thermal conductivity (W/cm deg)
GaN	3.43	3.0	1200	2.7	1.3
SiC	3.26	2.8	1000	2	4.9
Si	1.12	0.3	1350	1	1.51

# Goal of our IDER unit

- Establishment of the concept of GaN devices for power electronics applications



- Driving force for development and application of GaN devices
  - “Application-driven” development

# Unit members and specialty areas

Name	Specialty area
Yushi Miura	Power Electronics (PE) Engineering, Unit Leader
Mamoru Imade	GaN crystallization
Hiroaki Kakigano	PE Engineering, Distributed Generations
Yoshinari Kamakura	Device simulation
Fumio Kawamura	GaN crystallization
Osamu Saeki	Optimization Analysis
Hideharu Sugihara	Optimization Analysis
Rejeki Simanjorang	PE Engineering, Switching power supplies
Toshifumi Ise	PE Engineering, Unit Advisor
Hideo Iwamoto	Power Device Application, Unit Advisor

# Targets in the first phase (~2008)

1. Market research and Evaluation of required performance of next generation devices  
*⇒ feedback to crystallization engineering*
2. Literature research and construction knowledge database
3. Prediction of device performances and development of device design methodology  
*⇒ device simulation and optimization technique*
4. Establishment of implementation technology



# Targets in the second phase (2009~)

1. Device simulation of the GaN devices optimally-designed by the developed methodology
2. Preparation of GaN crystal for power devices

Our final targets are...

- Fabrication of the optimally-designed GaN power device ,
- Evaluation of performance of the circuits employing the GaN power devices.

# Present activities

- Literature research and construction of the knowledge base on the Web.
- Evaluation of performance of the next generation power devices at present.
  - Dynamic performance of passive circuit components such as inductors, capacitors, and resistors will be also investigated.

# Knowledge base on the Web

- For Knowledge management, knowledge base has been constructed on the Web using Blog technology.
  - Literature information
  - Technical intelligence
  - Seminar and lecture information
  - Activity reports

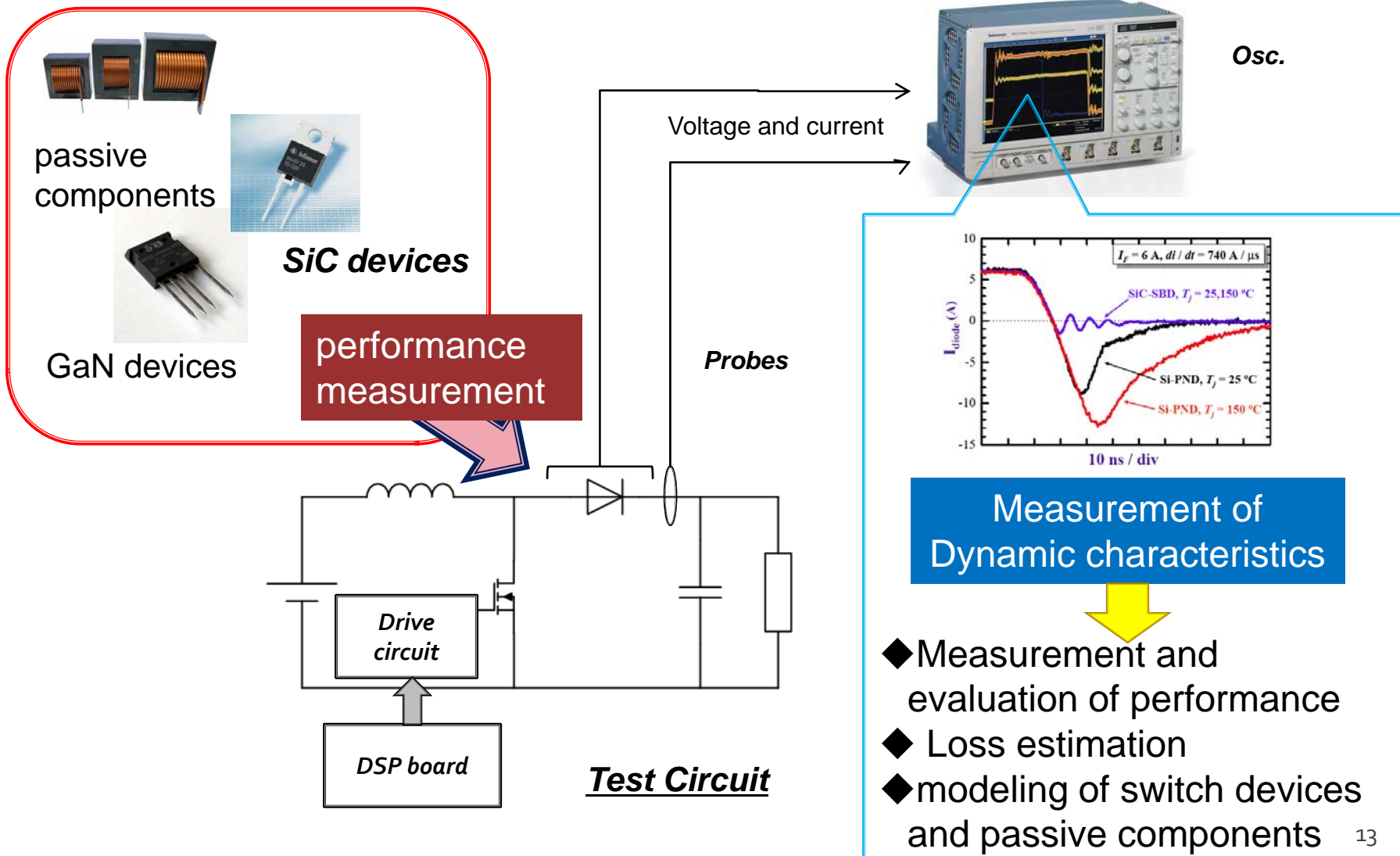
The screenshot displays a web browser window titled "IDER Power..." showing the "IDER Power Devices Knowledge Base". The page content includes:

- Header:** "IDER Power Devices Knowledge Base" with a subtitle: "「次世代パワーデバイスのコンセプト検討ユニット」のKnowledge Baseです。"
- Date:** 2007年10月26日
- Post Title:** 【技術資料】新規半導体(SiC,GaN)のパワーエレクトロニクスへの展開
- Text:** SiCを中心としたパワーデバイスの将来予測と、要求される性能についてのレポートです。  
「新規半導体(SiC,GaN)のパワーエレクトロニクスへの展開」  
荒井 和雄(独)産業技術総合研究所 パワーエレクトロニクス研究センター長  
樋口 登(独)産業技術総合研究所 次世代パワーエレクトロニクス実用化チーム チーム長
- Source:** 季報 エネルギー総合工学Vol29 No.3(2006.10)  
<http://www.iae.or.jp/publish/kihou/29-3/06.html>
- Author/Time:** 投稿者 Miura 場所 10:47 0コメント
- Post Title:** 予算申請終了いたしました
- Text:** 昨日10/25に予算申請書をGCOE事務局に提出してまいりました。申請金額は400万円です。11/6にヒアリングが行われる予定です。11/7には採択の可否と額が示されることになっておりますので、次回11/9のミーティングにおいて結果を報告したいと思います。よろしくお願いたします。
- Author/Time:** 投稿者 Miura 場所 10:42 0コメント
- Meeting Information:** 第2回ミーティングは11/9(Fri), 16:20-です。場所はCOE融合実践セミナー室(E5-312)です。  
<議事予定>  
・予算申請についての報告  
・岩本様ご講義

# Present activities

- Literature research and construction of the knowledge base on the Web.
- Evaluation of performance of the next generation power devices at present.
  - Dynamic performance of passive circuit components such as inductors, capacitors, and resistors will be also investigated.

# Evaluation of performance of the next generation power devices



# Summary

- To establish the concept for application of the GaN power devices, our IDER unit has been organized by the experts in different engineering fields.
- The device simulation method, the device design methodology and the circuit implementation technology, which will be interdisciplinary developed in this unit, will be novel tools for development and application of the power devices.