Electronic Materials Lab

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Member

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EDUCATION

- 1990– 1995, M.S. and Ph.D in Electroceramic Thin Films,
  Korea Advanced Institute of Science & Technology (KAIST), Korea
- 1986– 1990, B.S. in Materials Science & Engineering
  Korea Advanced Institute of Science & Technology (KAIST), Korea

RESEARCH EXPERIENCE

- 2002 – Present, Dong-Eui University, Busan, Korea
  Professor, Department of Mat. Components Eng. & Electronic Research Center (ECC)
- 2009 – 2010, University of Maryland at College Park, MD, USA
  Visiting Scholar, AZO films by Atomic Layer Deposition (ALD) and characterization of their electrical properties for TCO application.
- 1997 – 2002, Electronics and Telecommunications Research Institute (ETRI), Daejon, Korea
  Senior Research Engineer, ETRI-Micro-Electronics Technology Lab.
- 1996 – 1997, North Carolina State University, Raleigh, NC, USA
  Post-doctor, Department of Materials Science and Engineering
  Process development of BST films using a liquid delivery source MOCVD process

MAIN RESEARCH AREAS

- SiC Single Crystal & epitaxial growth by PVT method and their characterization as a wafer.
- GaN wafer fabrication by HVPE technique.
- ZnO thin films deposited by pulsed laser deposition (PLD) technique
- Dielectric layers grown by plasma enhanced atomic layer deposition (PEALD) process.
- International Journals; 160, Patents; 50

Member

Researcher

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Single crystal growth
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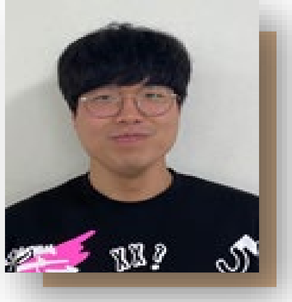

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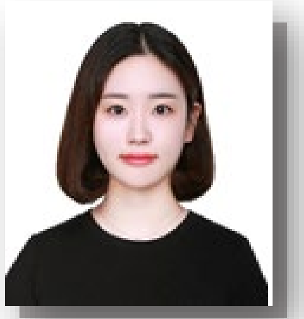
Hae-Jin Jeon (Senior)
jjjjhj0813@gmail.com



Hui-Yeon Jang (Senior)
wkddmsgk7848@naver.com

Overview

Electronic Material Lab

Main Research Area

- Single Crystal Growth of Compound Semiconductor
- Electronic Ceramics
- Ceramic Thin Film / Component
- Wafer Processing and Analysis
- Numerical Simulation

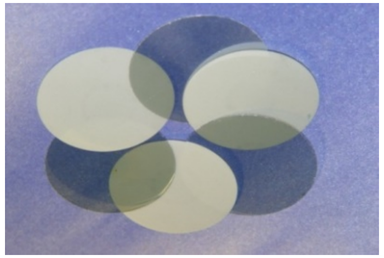
Overview

Crystal Growth

- Single crystal growth of various materials used in semi-conductor or display by Sublimation Growth or Solution Growth
  - SiC, AlN, Semi-insulator SiC

- Epitaxial growth on substrate using PVD or CVD
  - GaN, ZnO, TiO_2, SiC, Ga_2O_3



Processing (Wafering)

- Equipped to process grown ingot into wafers (Wafering)
- Cutting : Multi-Wire Saw, Single-Wire Saw, Blade Cutter
- Surface : Grinder, Lapping, DMP, CMP
- Others : Lateral Grinder, Edge Grinder, Seeding Equipment, Plasma Etcher

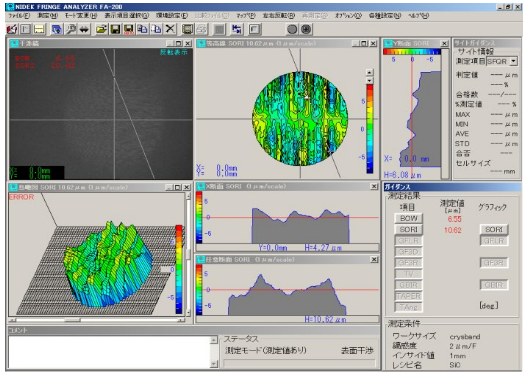


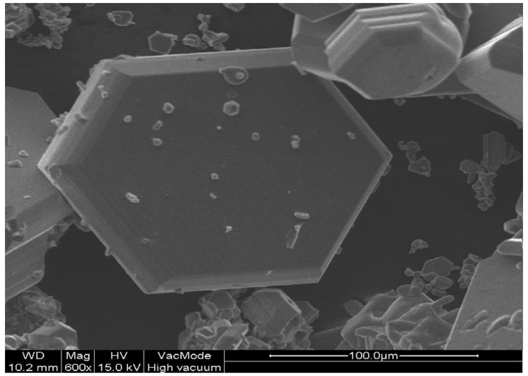


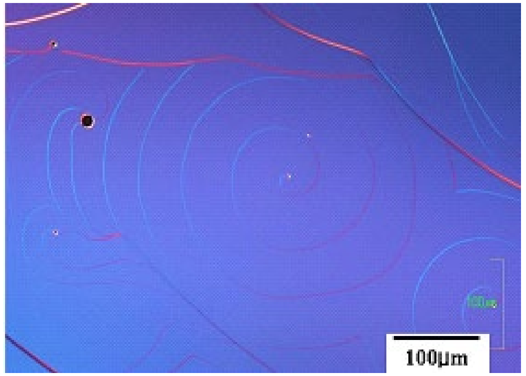

Overview

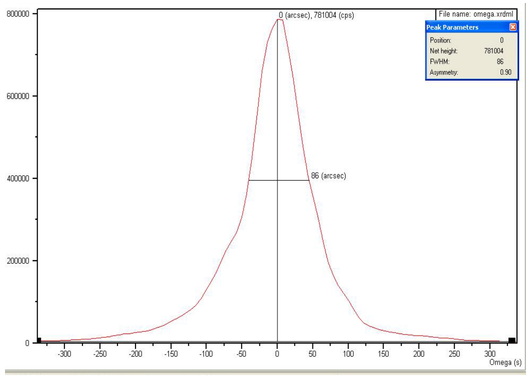
Analysis

- Analyzing crystallographic quality and defect of single crystal
  - XRD, HR-XRD, Goniometer
- Surface quality analysis
  - OM, AFM, Wetting Angle, SEM /EDS
- Electrical properties analysis
  - Hall measurement, UVF



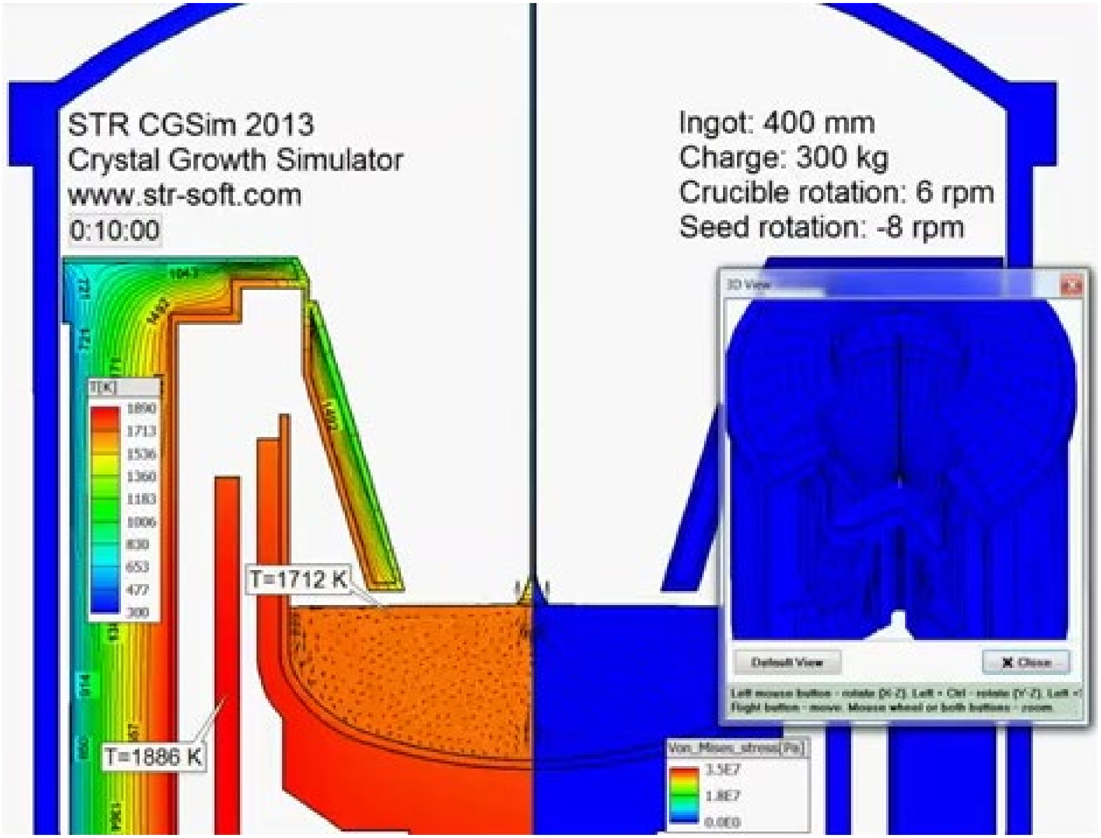






Simulation

- Optimization of experiment condition by simulating a single crystal growth to predict temperature distribution, growth rate and fluid flow
  - CGSim, Virtual Reactor



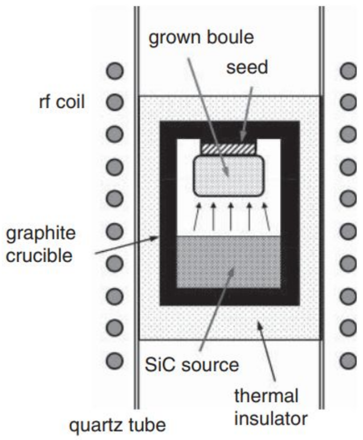
[Ref.] STR Group, www.str-soft.com

SiC Single Crystal

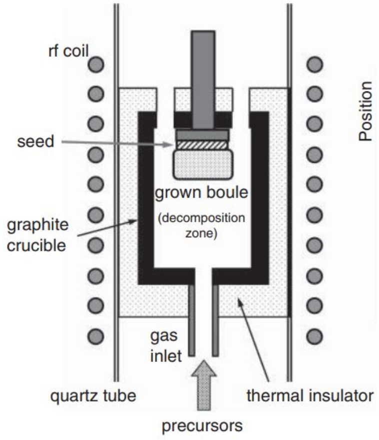
SiC

- SiC (Silicon Carbide) is a promising substrate applicable to power device working at high power, high frequency and high temperature.

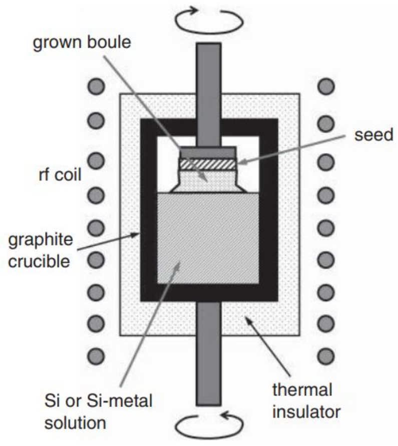
PVT



CVD

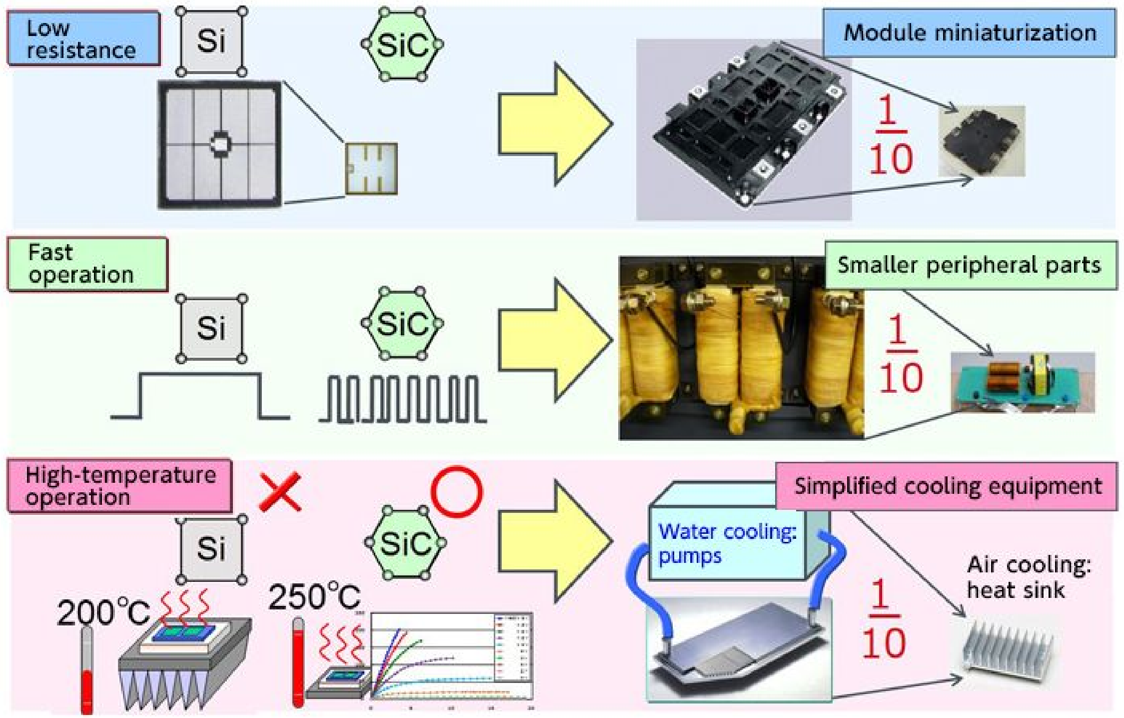


TSSG



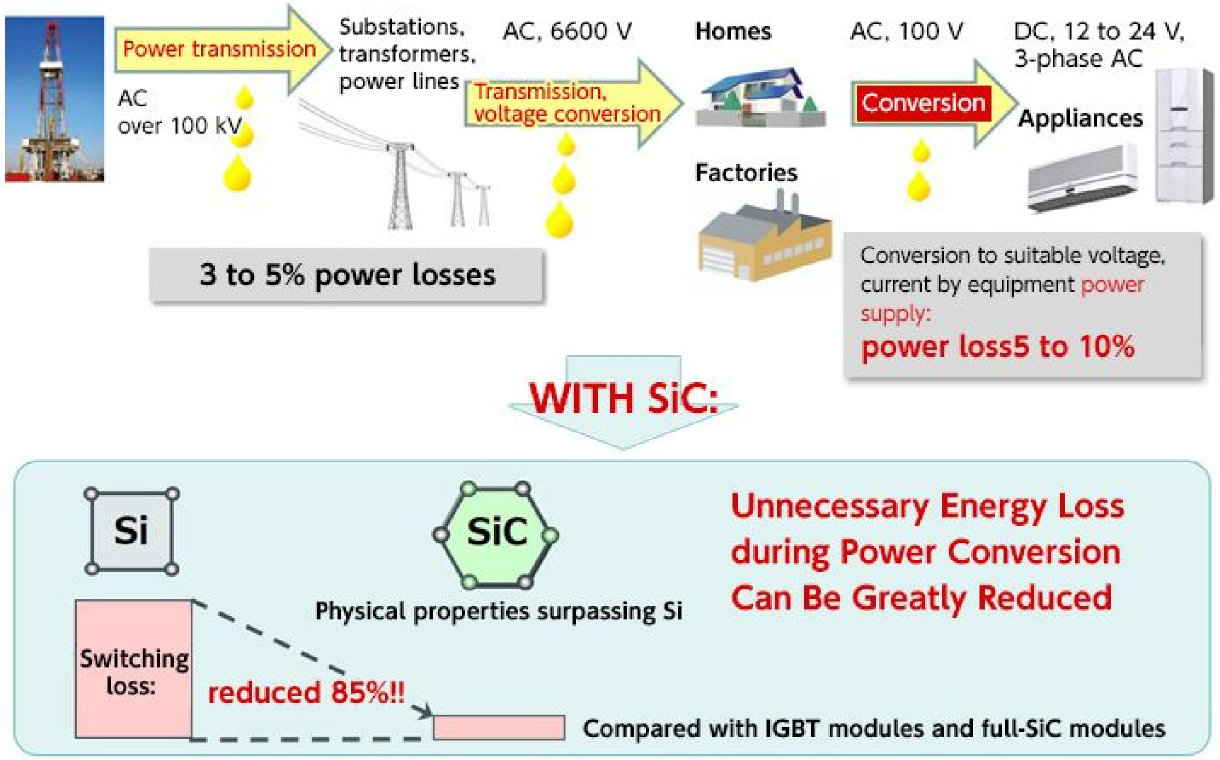
[Ref.] Fundamentals of Silicon Carbide Technology_ Growth, Characterization, Devices and Applications-Wiley-IEEE Press (2014)

Advantage



[Ref.] Tech web, https://micro.rohm.com/en/techweb/knowledge/sic/s-sic/02-s-sic/4161

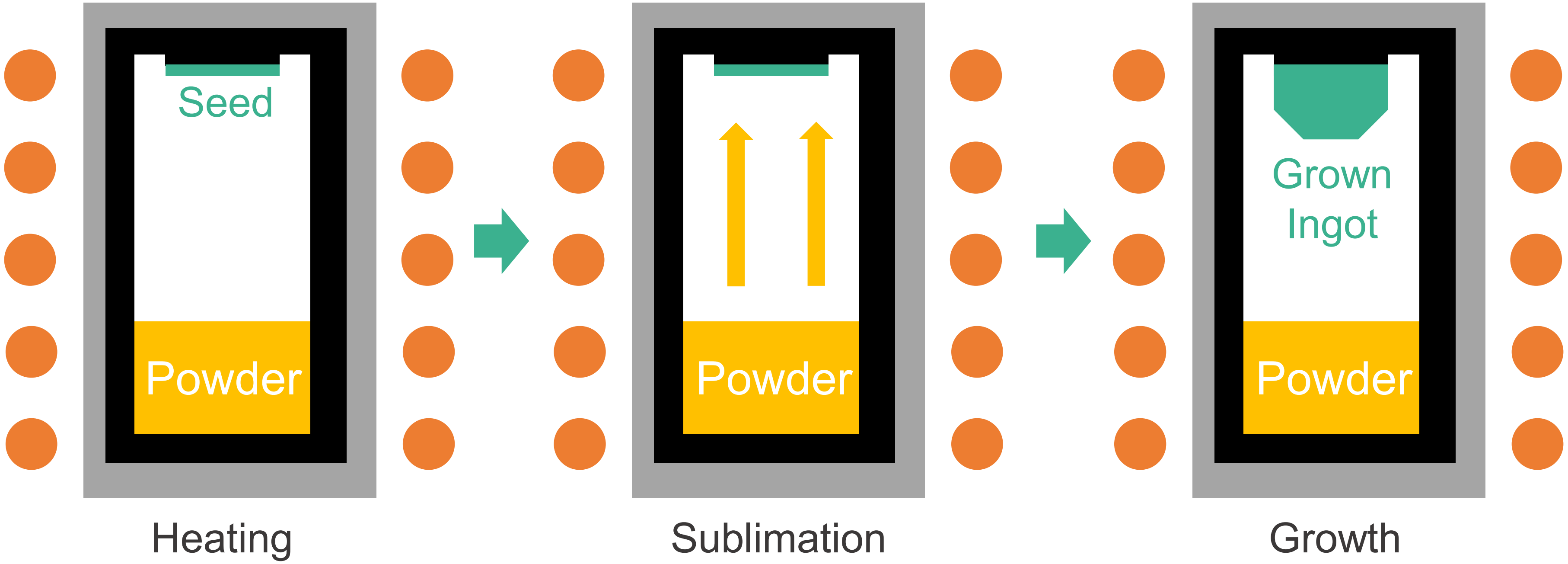
Application



PVT

PVT

- PVT (Physical Vapor Transport) is sublimation growth with seed and standard method for growing single crystal SiC



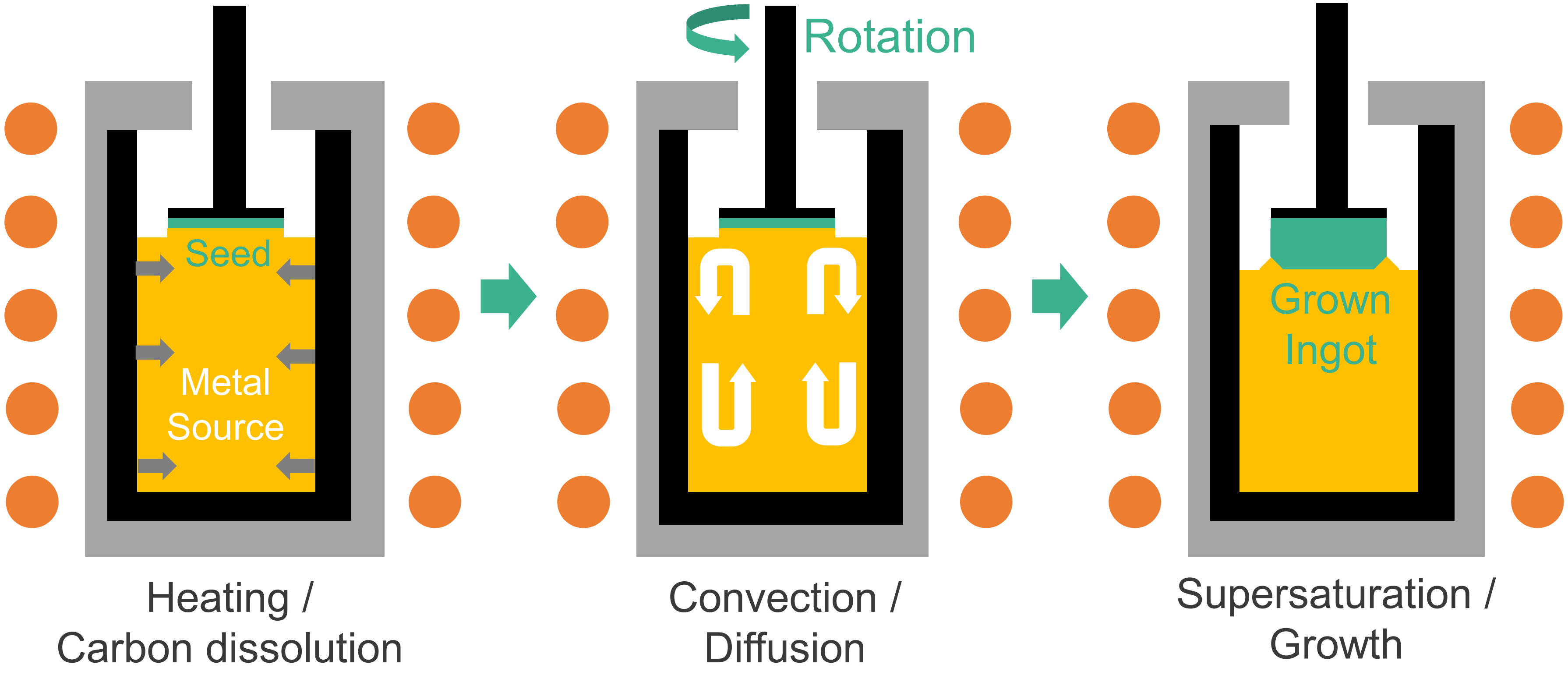
PVT grower

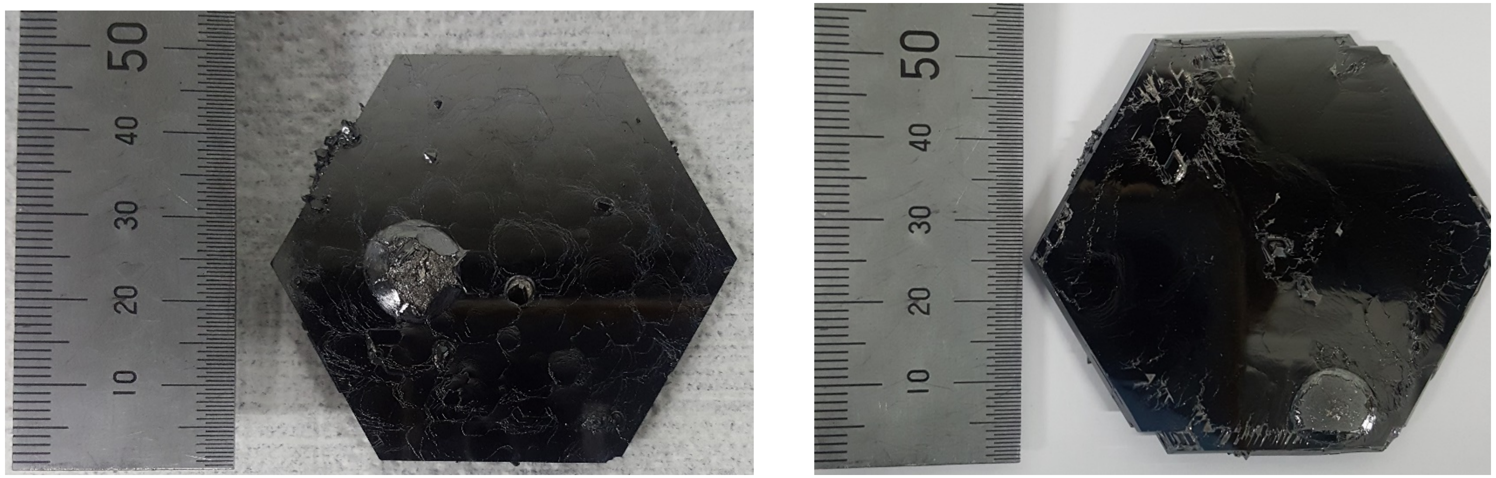
SiC Ingot

TSSG

TSSG

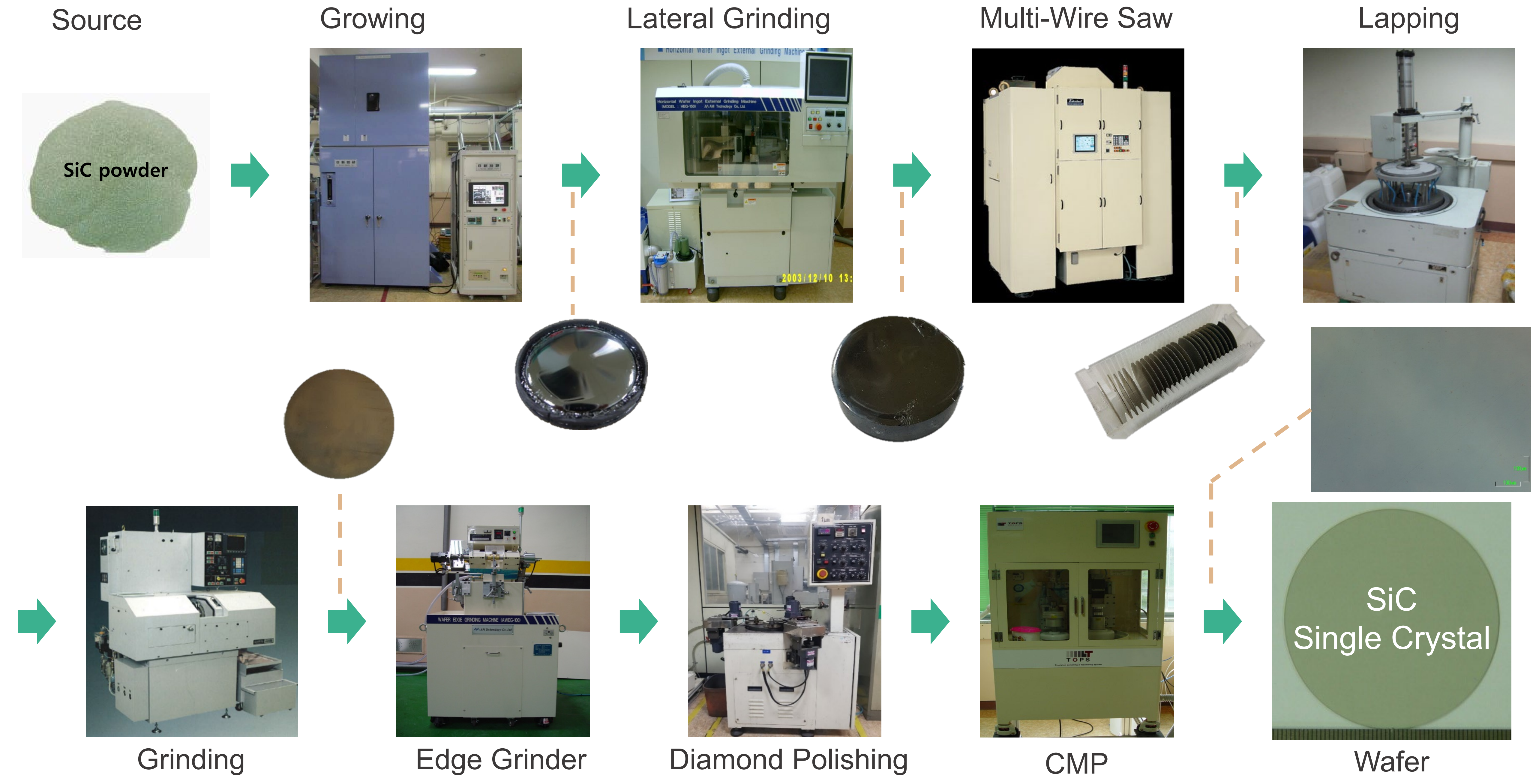
- TSSG (Top-Seeded Solution Growth) is alternative method growing high quality SiC crystal under a close condition to thermodynamic equilibrium state





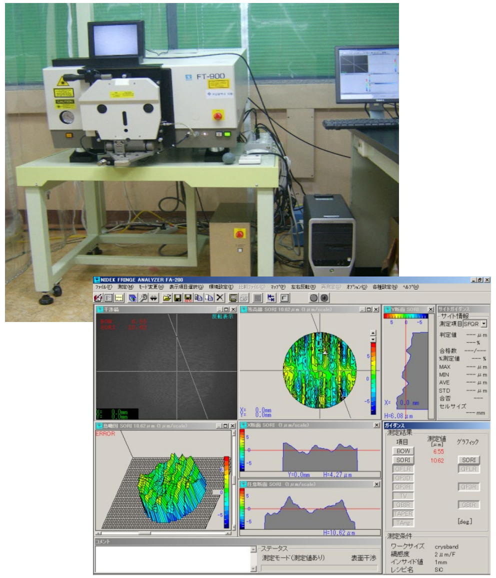
SiC Ingot

Manufacturing Process

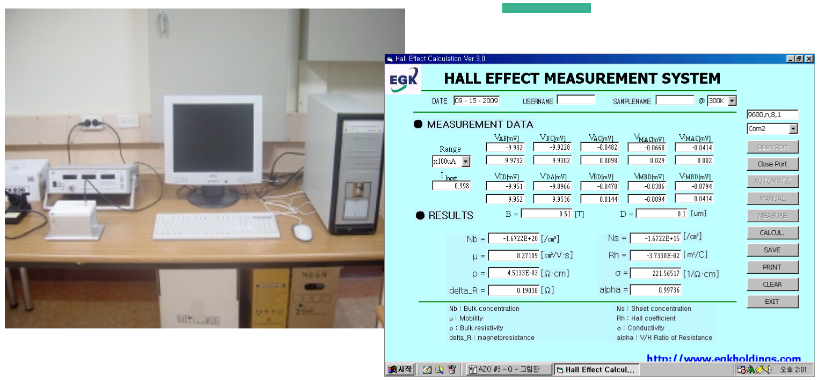


Analysis system for Single Crystal

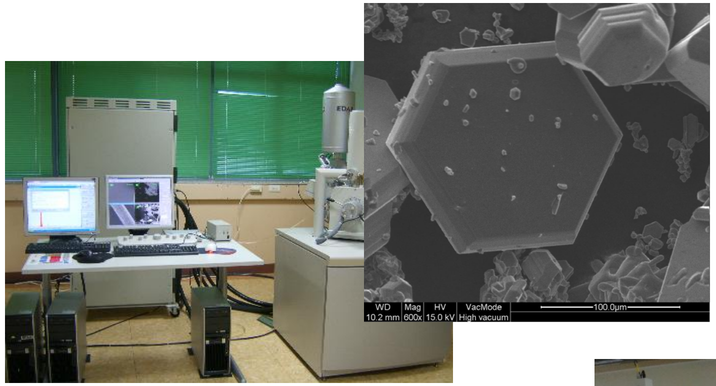
Flatness Tester



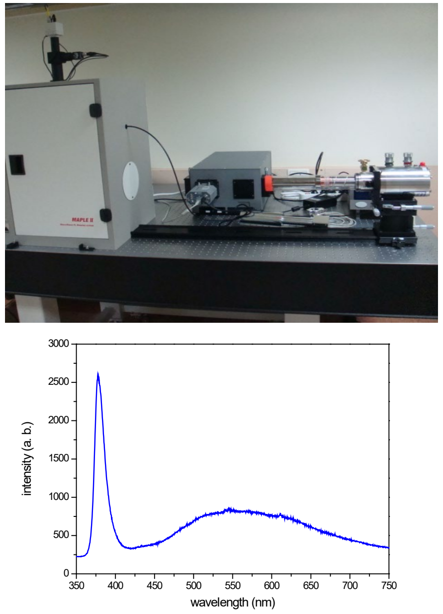
Hall Measure System



FE-SEM / EDS

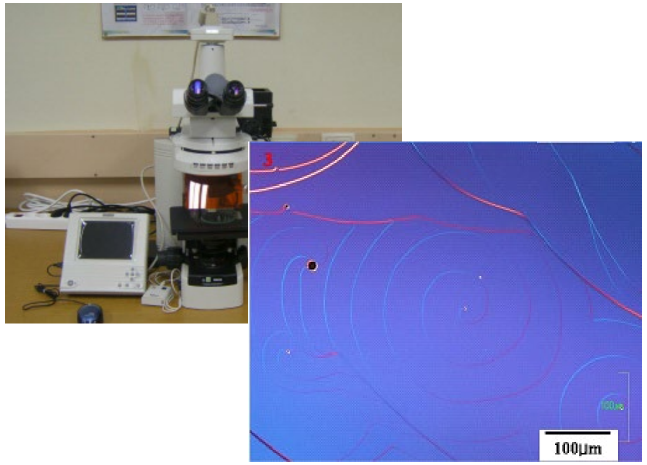


CL / PL

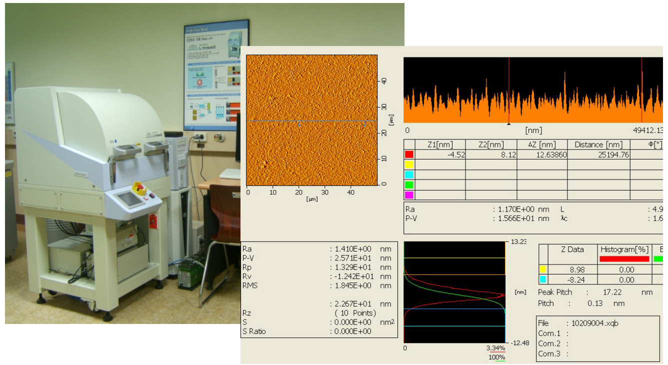


- Flatness tester: wafer Bow/Sori
- HR-XRD: Rocking curve data
- FE-SEM/EDS: Microstructure, composition
- OM/Polarizer: Stress, Defect
- CL/PL: Defect
- Large Area AFM: Roughness
- Hall Measure System: Electrical data

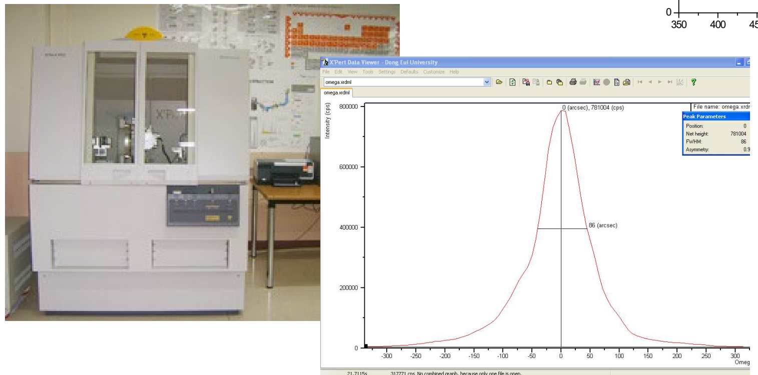
OM / Polarizer



AFM



HR-XRD



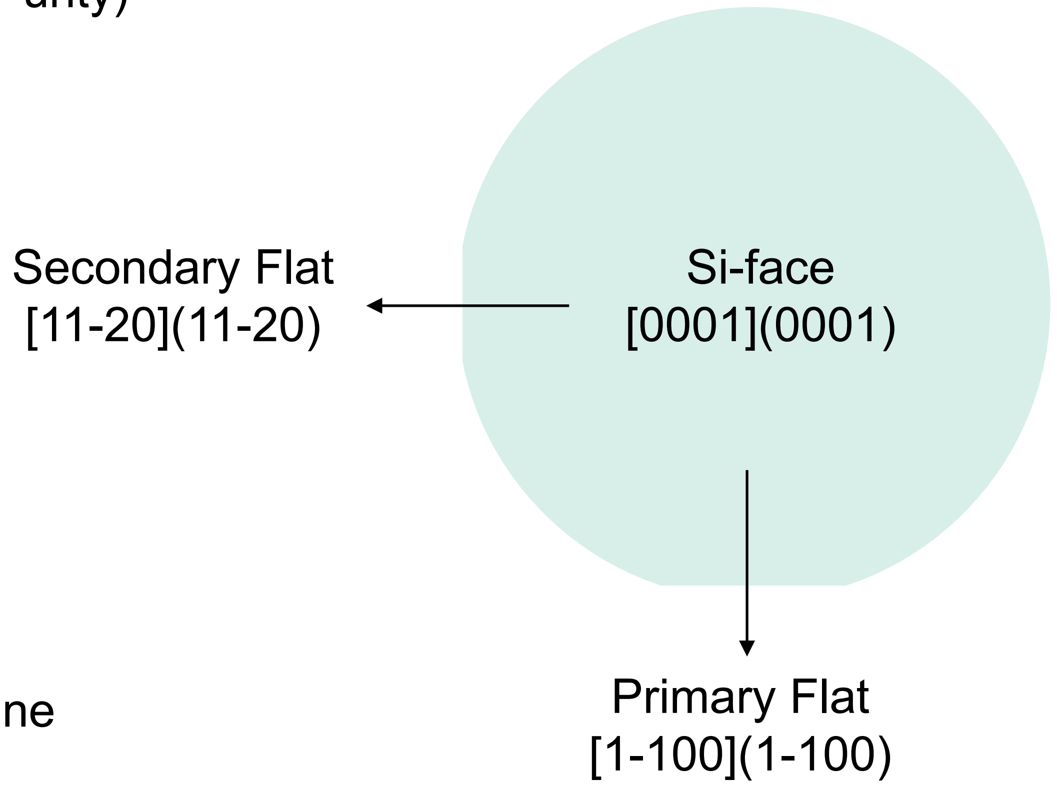
SiC Substrate

Doping

- N-type(N)
- P-type(Al, B)
- Semi-Insulating (V, High Purity)

Surface

- Si-face, C-face
- Optical polish: single, double-side polish ($R_a \leq 3nm$)
- Standard polish: Epi ready ($R_a \leq 2nm$)
- CMP, Epi ready ($R_a \leq 1nm$)



Plane

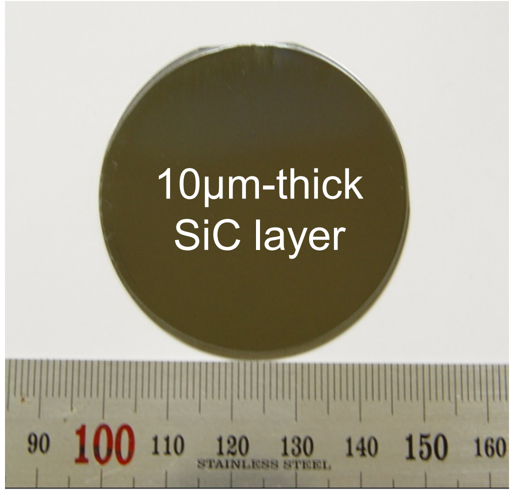
- on-axis (c-axis)
- off-axis(4.0^{o}-off, 8.0^{o}-off)
- Positive Polarity : Si-face
- Negative Polarity : C-face
- Non-polar : a-plane, m-plane
- Semi-polar : r-plane

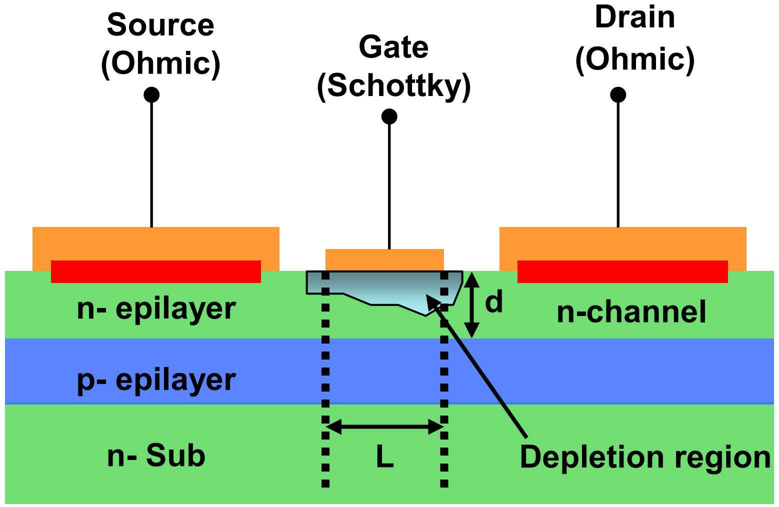
Defect

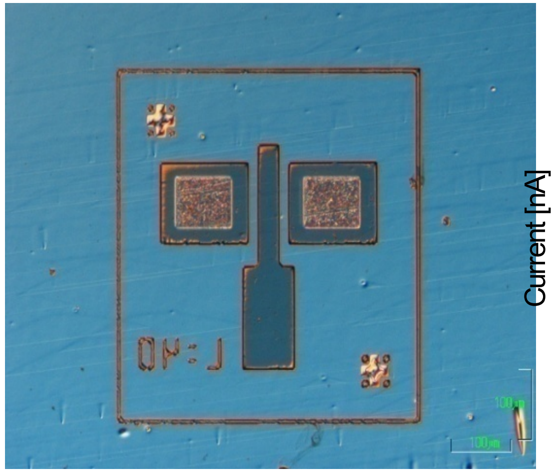
- Micropipe (MP)
- Foreign Polytype
- Edge exclusion
- Dislocation
- Stacking Fault
- Bow
- Scratch

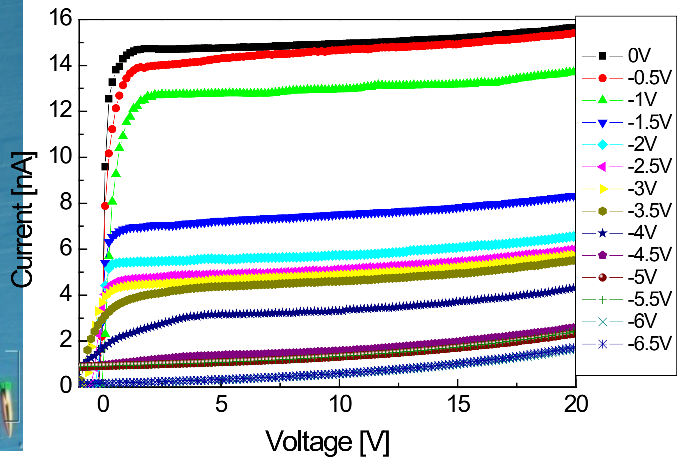
SiC Epitaxial Layer and MOSFET Device

2”-SiC epitaxial layer









Publications

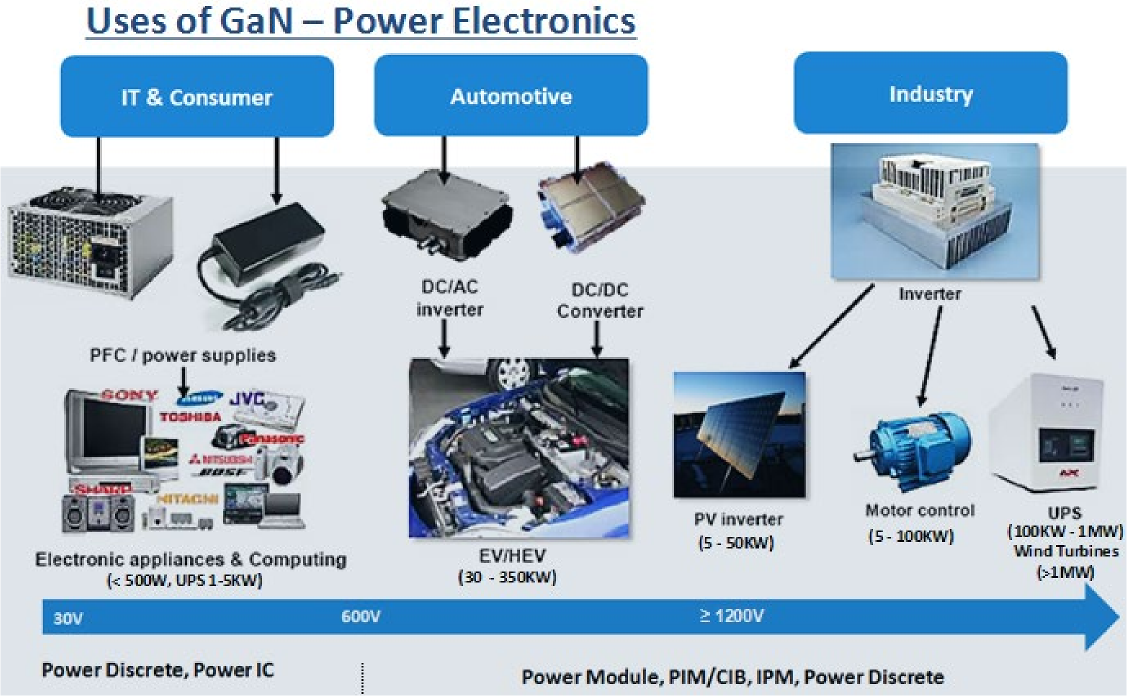
- High Quality SiC Crystal with New Crucible Design, ***Mater. Sci. Forum.*** Vol. 527-529 (2006) 83-86.
- Epitaxial Growth of 4H-SiC (0001), ***Mater. Sci. Forum.*** Vol. 527-529 (2006) 267-270.
- Inserted Epitaxial Layer for High Quality SiC Single Crystal, ***Mater. Sci. Forum.*** Vol.556-557 (2007) 9-12
- Hydrogen Effect on SiC Single Crystal, ***Mater. Sci. Forum.*** Vol.556-557 (2007) 25-28
- p-type Epitaxial Layers using Various Si/Al ratios, ***Mater. Sci. Forum.*** Vol. 556-557 (2007) 153-156
- CMP Process Parameters of 6H-SiC(0001), ***Mater. Sci. Forum.*** Vol .600-603 (2009) 831-834
- Initial Stage Modification for 6H-SiC Crystal, ***Mater. Sci. Forum.*** Vol. 615-617 (2009) 7-10
- Seed Polarity Dependence of SiC Crystal Growth ***J. Kor. Phys. Soc.*** Vol.54, No.5 (2009) 1834-1839
- Non-polar SiC substrate, ***Mater. Sci. Forum.*** Vols. 645-648 (2010) pp 37-40
- a-plane (11-20) 6H-SiC Crystal Grown, ***J. Korean Physical Society***, Vol. 58, No. 5 (2011) pp1541-1544
- Comparative study on dry etching of α- and β-SiC nano-pillars, ***Materials Letters*** 87 (2012) 9–12
- Modified Crucible Design and Seed Attachment , ***Mater. Sci. Forum***, Vols. 740-742 (2013) pp 77-80

GaN Epitaxial Wafer

GaN

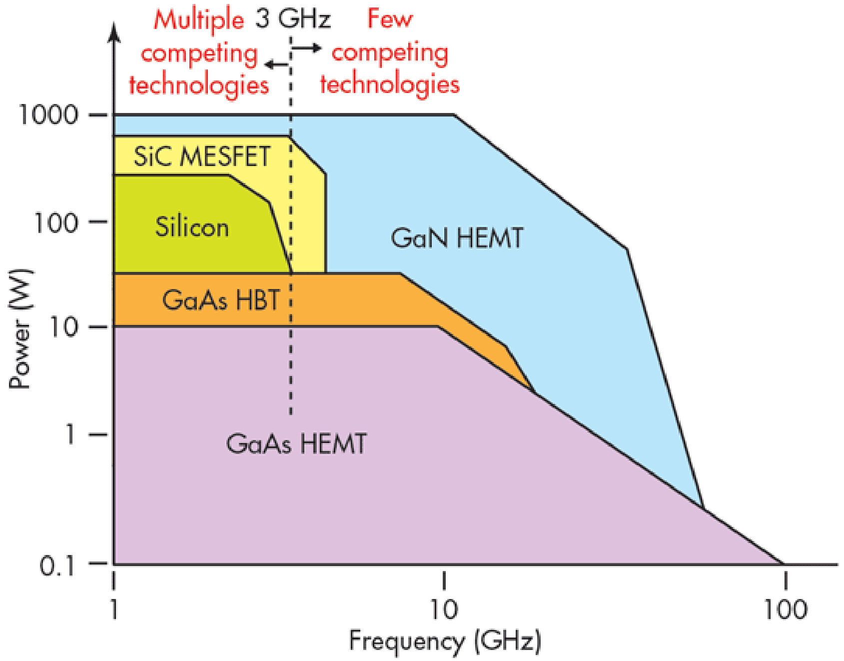
- GaN (Gallium Nitride), which is used in semiconductor power device as well as RF components and LEDs, enables high-speed, increase efficiency and higher power density

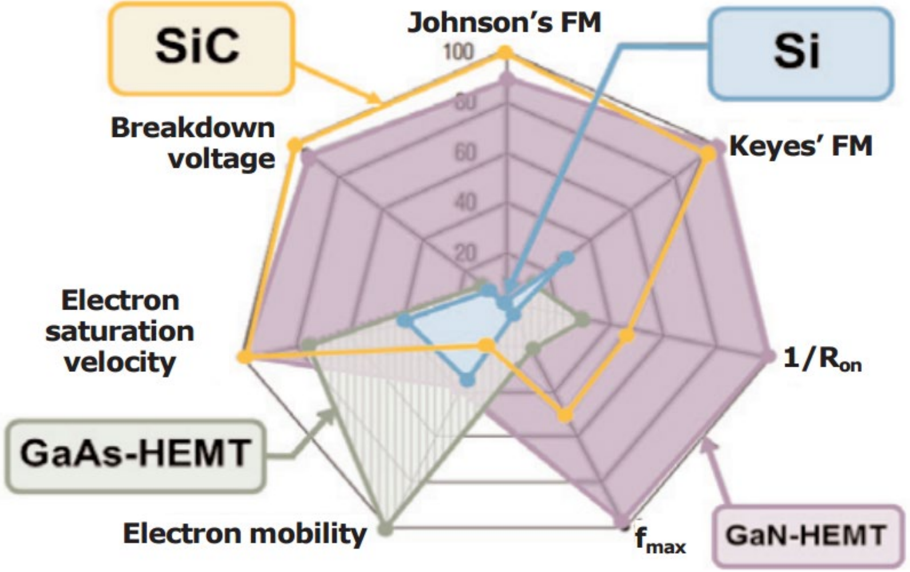
Application



[Ref.] http://uef.fei.stuba.sk/moodle/mod/book/print.php?id=7920

Advantage



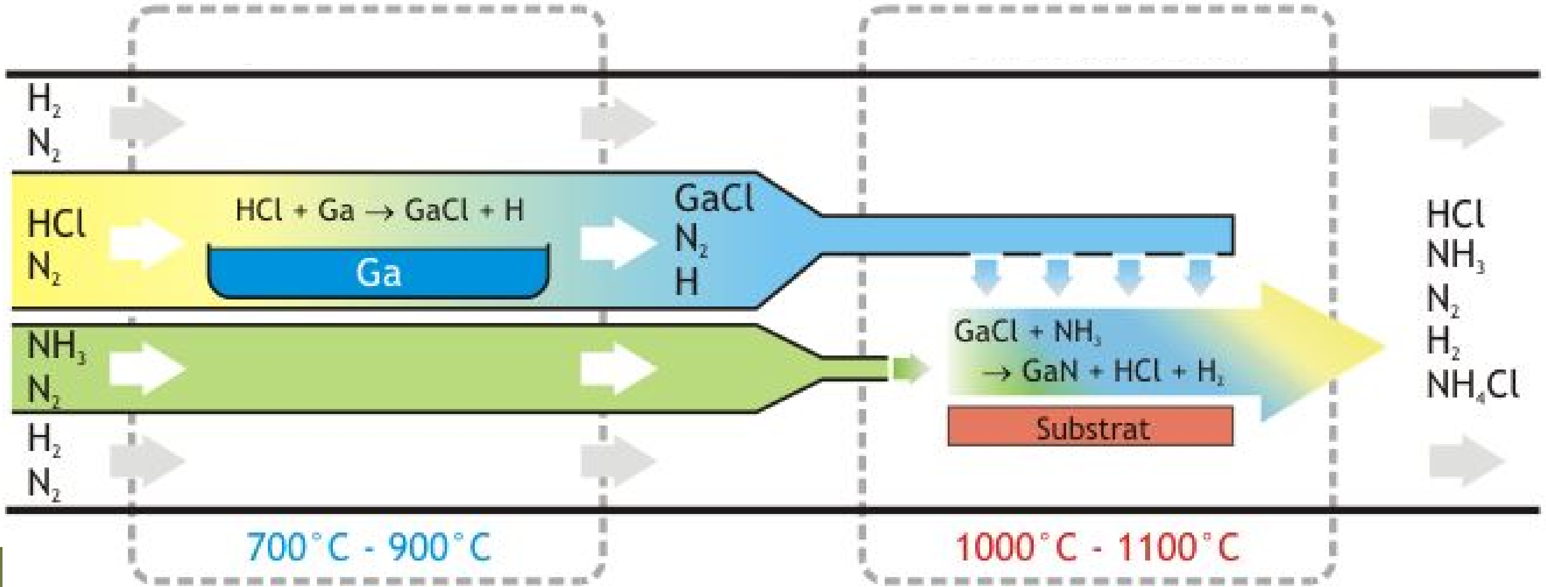


[Ref.] http://uef.fei.stuba.sk/moodle/mod/book/print.php?id=7920

HVPE system for GaN crystal growth

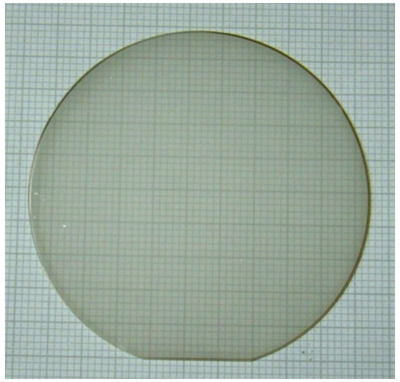
HVPE

- HVPE (Hydride Vapor Phase Epitaxy), which is which gaseous metal chlorides react with ammonia to produce the group-III nitrides, is an epitaxial growth method such as GaN, GaAs and InP.

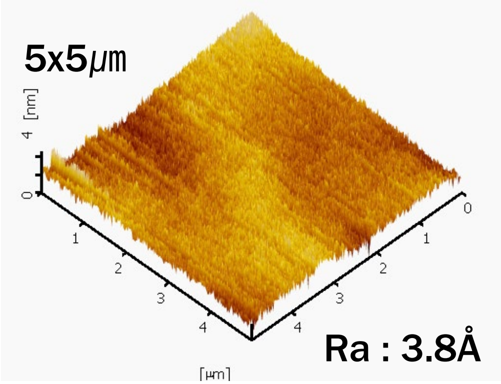


[Ref.] WIKIMEDIA COMMONS, https://commons.wikimedia.org/wiki/File:Schema_HVPE-Reaktor_de.png

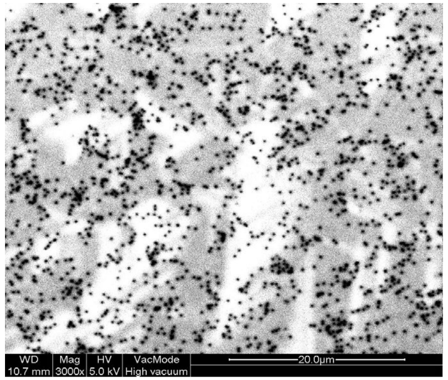
GaN on Sapphire (2 inch)



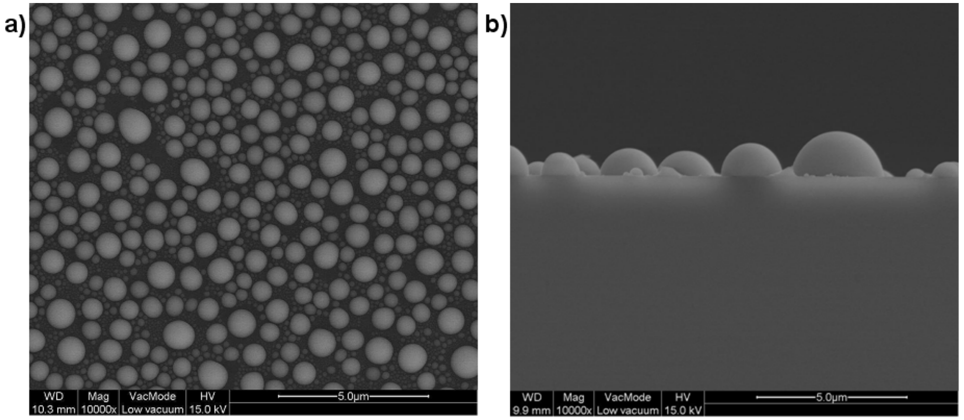
AFM data

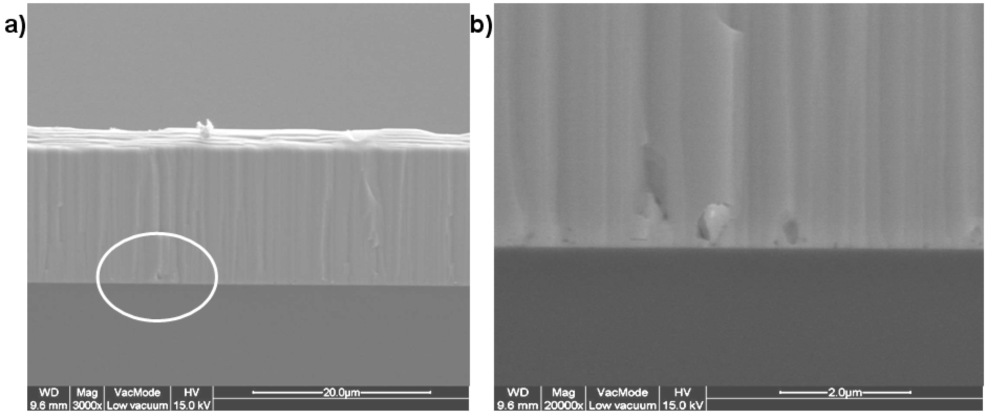


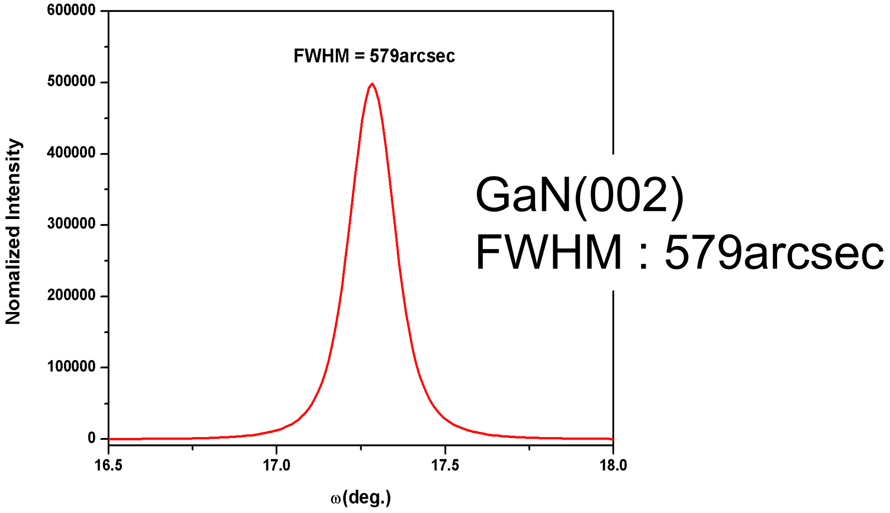
Defect of GaN

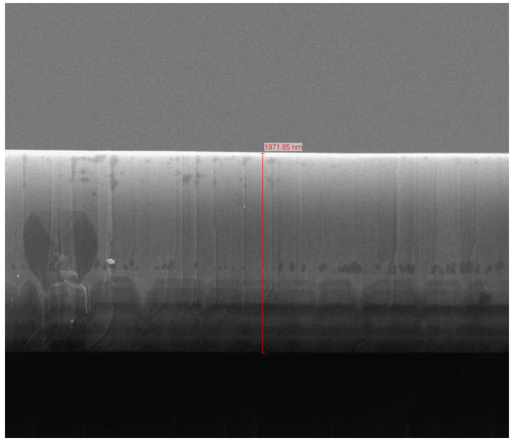


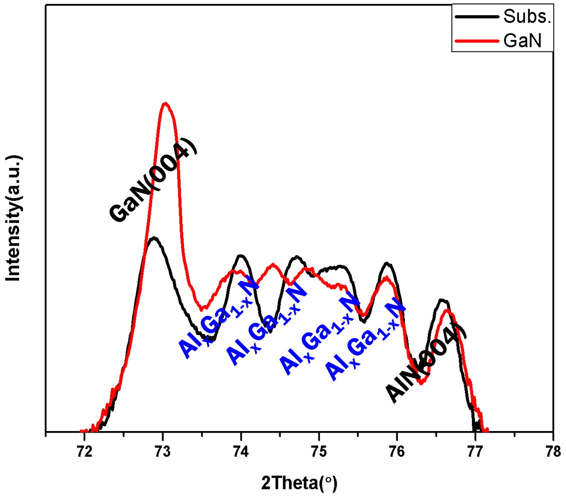
GaN growth by HVPE method









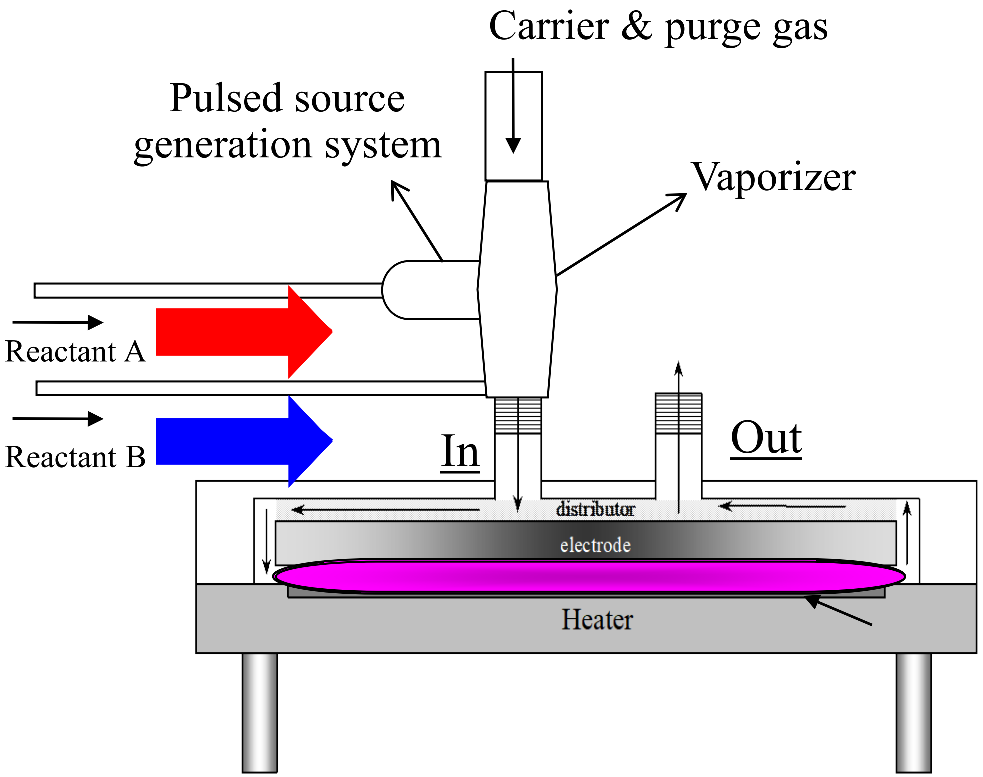


GaN/AlGaN buffer/Si Structure

Recent Publications

- GaN by HVPE technique, ***Phys. Status. Solidi C*** Vol. 7 (2010) 1770-1774
- GaN by HVPE and MOCVD methods, ***Phys. Status. Solidi C*** Vol. 7 (2010) 1794-1797
- Epitaxy of GaN on Si(111) substrate, ***Journal of Crystal Growth***, (2013)

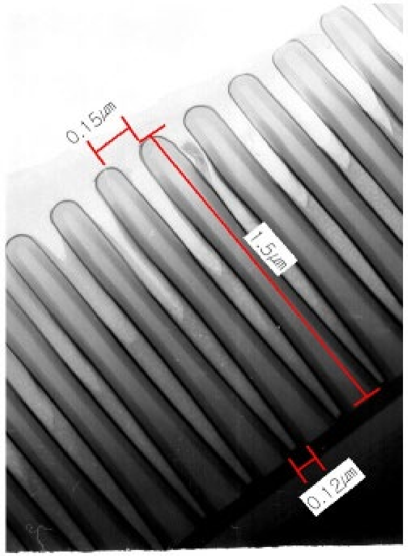
PEALD system for oxide films

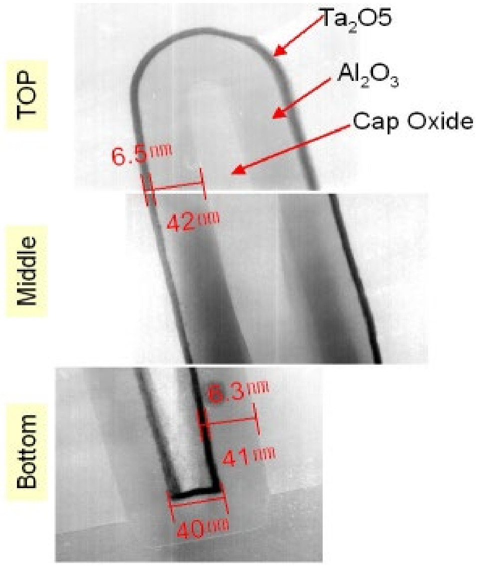


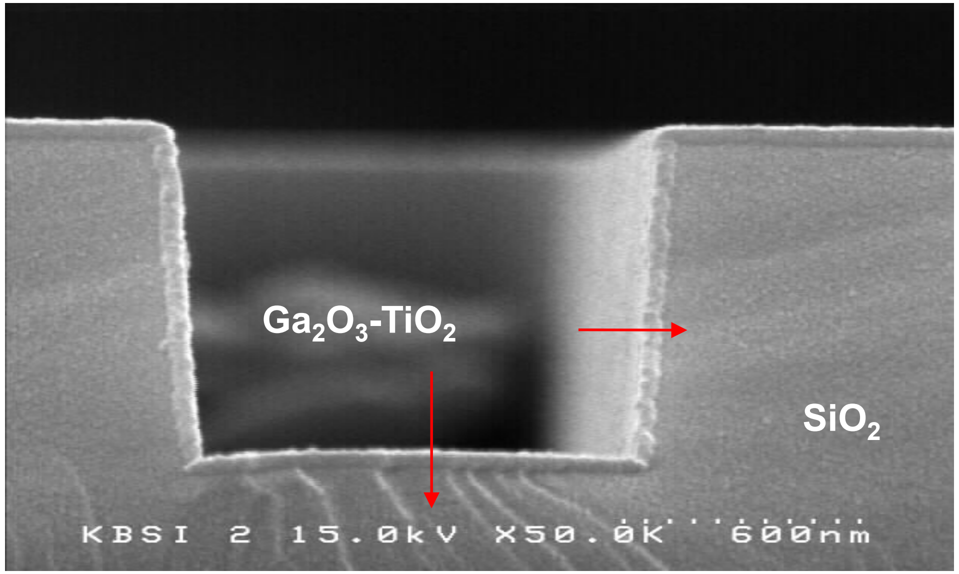
Main specification

- 5-inch wafer loading
- RF generator for plasma enhancement
- Injector(Vaporizer) for liquid source

Dielectric thin films by PEALD / PLD



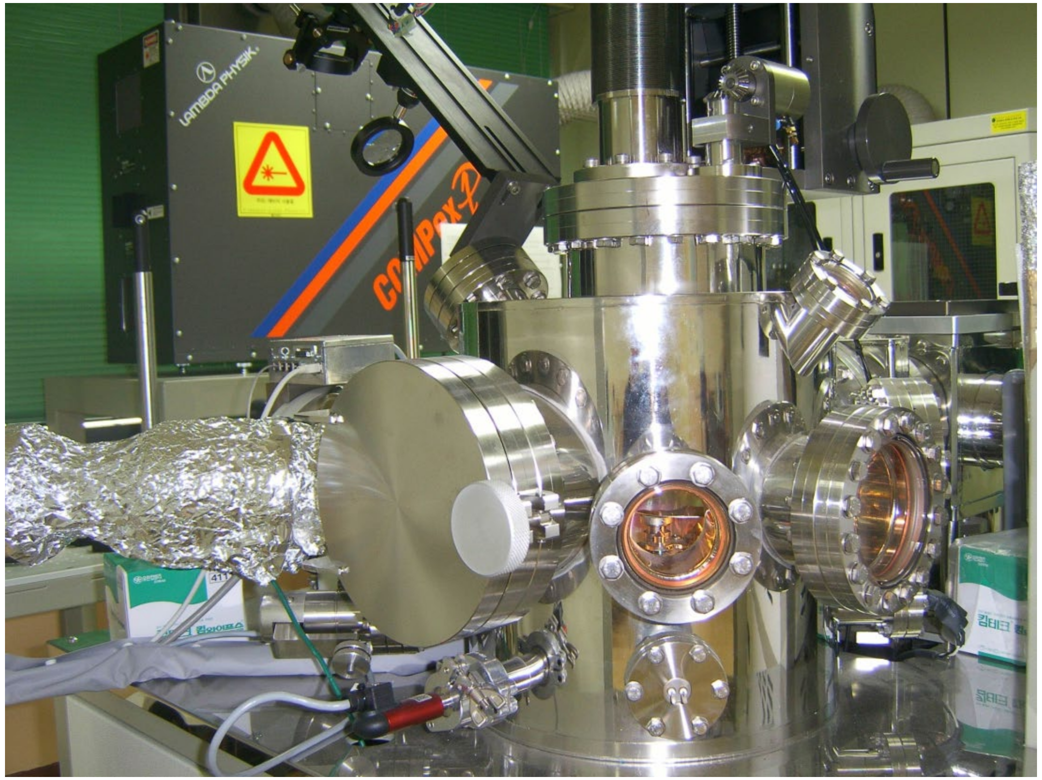


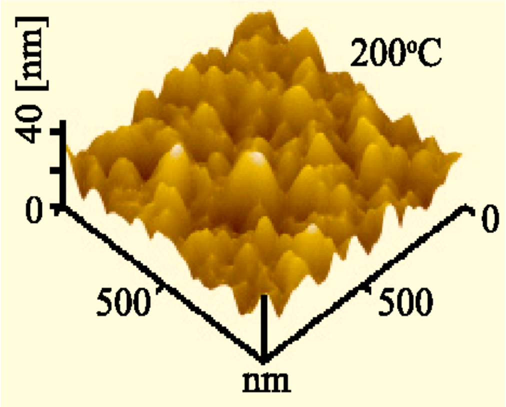


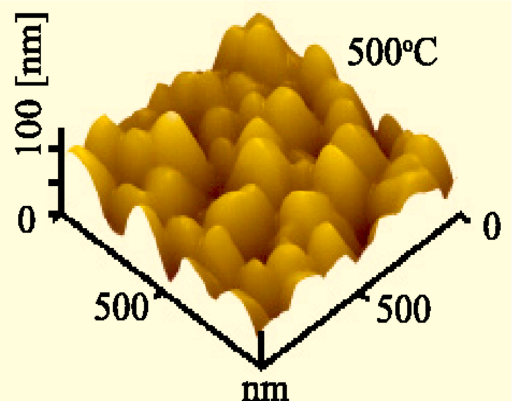
Recent Publications

- Gallium Oxide thin film, ***J. Appl. Phys.*** Vol. 98 (2005) 023504
- Ga_2O_3-TiO_2 nanomixed films, ***Appl. Phys. Lett.*** Vol.87 (2005) 082909
- Ga_2O_3-based thin films, ***J. Electroceramics,*** 17 (2-4) (2006) 145-149.
- Growth Temperature Dependence of TiO2. ***J. Korean Phys. Soc.*** Vol. 50 (6) (2007) 1827-1832
- Al0.016In0.003Zn0.981O by PLD, ***J. Electrochemical Soc.***,Vol. 155, 10 (2008) H786-H790
- Bi3NbO7 Films by Nanocluster Deposition, ***Electrochemical Solid-State letter***, 12 (5) (2009) G23-G26
- ITO by NCD technique, ***J. Electrochemical Soc.***, Vol. 157, 10 (2010) H937-H941
- Atomic layer deposition Al-doped ZnO films, ***J. Appl. Phys.*** 108, (2010) 043504
- $0.65Pb(Mg_{1/3}Nb_{2/3})O_3$–$0.35PbTiO_3$ epitaxial films, ***Sensors and Actuators B*** 155 (2011) 854–858
- Structural and Optical Properties of TiO2 Films on Glass Substrate, ***Jpn J Appl Phys*** 51 (2012) 09MF12
- Selective growth of pure magnetite thin films, nanowires, ***J. Mater. Chem. C.,*** (2013) 1, pp.1977–1982

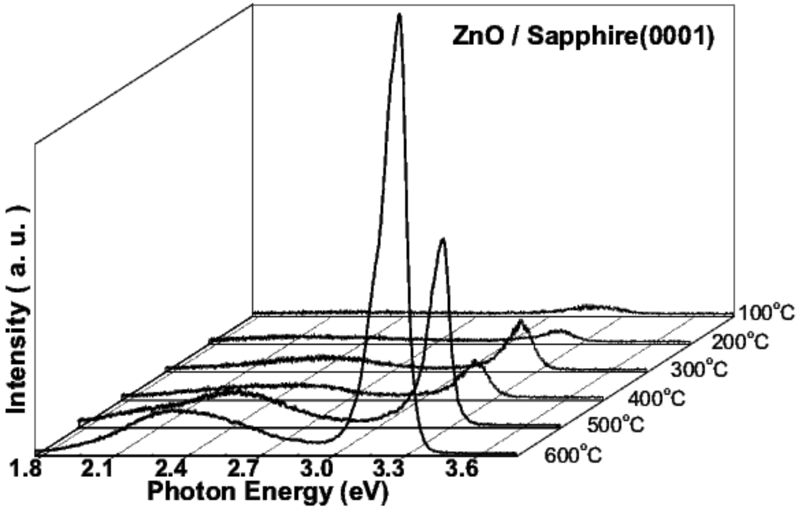
PLD system for ZnO / doped-ZnO

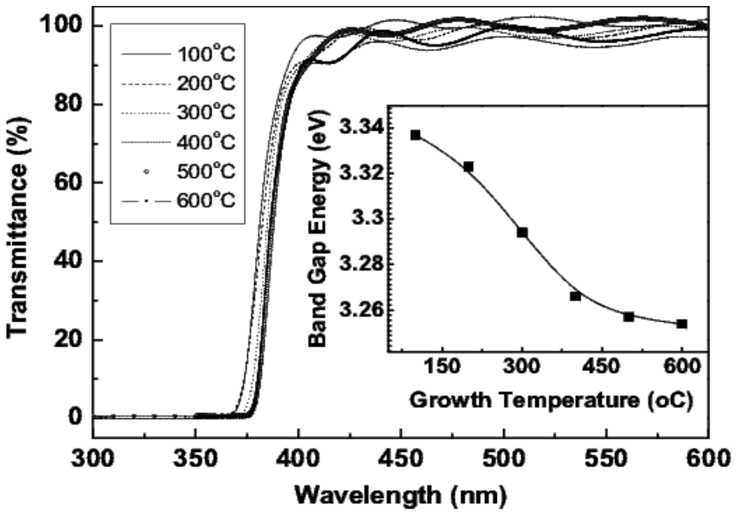






ZnO / doped-ZnO Thin Films





Recent Publications

- Mg doped ZnO thin films and aging, ***J. Appl. Phys.*** Vol. 95(9) (2004) 4772-4776
- ZnO thin films on sapphire (0001) substrates ***J. Electroceramics.*** 13 (2004) 189-194
- Deep-level emission in ZnO thin films ***Appl. Phys. Lett.*** 86 (2005) 221910
- Transparent Conductive ZnO thin films on glass substrates ***J. Crystal Growth.*** 277 (2005) 284-292
- Stokes shift, blue shift and red shift of ZnO ***J. Crystal Growth.*** 291 (2006) 328-333.
- Ga:ZnO thin films on sapphire substrates ***J. Electroceramics***, 17 (2-4) (2006) 287-292.
- In_2O_3-Doped ZnO Thin Films ***J. Korean Phys. Soc***, Vol. 50 (3) (2007) 626-631.
- The role of oxygen vacancies in epitaxial-deposited ZnO thin films. ***J. Appl. Phys.*** Vol. 101 (2007) 053106
- Na-Doped ZnO Thin Films, ***J. Nanoscience and Nanotechnology***, Vol. 8, (2008) 5203-5207
- Boron and nitrogen co-doped ZnO Thin Films, ***Ceramics International***, Vol. 34 (2008) 1011-1015
- Codoping in ZnO by AlN, ***Vacuum*** Vol. 83 (2009) 1081-1085
- Zn1-xCrxO thin films, ***J. Alloys Compd.*** Vol.478 (2009) 45-48
- In-doped ZnO nanorods, ***Appl. Phys. Lett.*** Vol. 94, (2009) 041906
- ZnO/SiC, ***J. Crystal Growth*** Vol.312 (2010) 2393-2397

Thank you

Questions & Comments !