

# ECE 6194.09 (Proposed): Group Studies Oxide Semiconductors: Materials and Devices

## Course Description

We will study the fundamentals of c-axis-aligned crystalline indium-gallium-zinc oxide (CAAC-IGZO) semiconductors. Phase diagrams, crystal structures, fabrication process, defect levels, origin of main donors, and electrical conduction mechanisms will be discussed. CAAC-IGZO based field-effect transistors will be introduced. We will cover the basics of the emerging ultrawide band Ga<sub>2</sub>O<sub>3</sub> and In<sub>2</sub>O<sub>3</sub>.

**Prior Course Number:** 694

**Transcript Abbreviation:** Grp Std Oxide Semi

**Grading Plan:** Letter Grade

**Course Deliveries:** Classroom

**Course Levels:** Graduate

**Student Ranks:** Masters, Doctoral

**Course Offerings:** Autumn

**Flex Scheduled Course:** Never

**Course Frequency:** Even Years

**Course Length:** 14 Week

**Credits:** 3.0

**Repeatable:** No

**Time Distribution:** 3.0 hr Lec

**Expected out-of-class hours per week:** 6.0

**Graded Component:** Lecture

**Credit by Examination:** No

**Admission Condition:** No

**Off Campus:** Never

**Campus Locations:** Columbus

**Prerequisites and Co-requisites:**

**Exclusions:**

**Cross-Listings:**

**Course Rationale:** To prepare graduate students with basic understanding of the oxide semiconductors - a research area ECE program currently focuses on.

**The course is required for this unit's degrees, majors, and/or minors:** No

**The course is a GEC:** No

**The course is an elective (for this or other units) or is a service course for other units:** Yes

**Subject/CIP Code:** 14.1001

**Subsidy Level:** Doctoral Course

## Programs

Abbreviation	Description
EE	Electrical Engineering

## Course Goals

Master the understanding of fundamentals of oxide semiconductors

Master the state-of-the-arts of the emerging Ga<sub>2</sub>O<sub>3</sub> and In<sub>2</sub>O<sub>3</sub>

## Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Layered Compounds in the In <sub>2</sub> O <sub>3</sub> -Ga <sub>2</sub> O <sub>3</sub> -ZnO System and Related Compounds in the Ternary System- Syntheses and Phase Equilibrium Diagrams	1.5							
Layered Compounds in the In <sub>2</sub> O <sub>3</sub> -Ga <sub>2</sub> O <sub>3</sub> -ZnO System and Related Compounds in the Ternary System- Crystal Structures	3.0							
Layered Compounds in the In <sub>2</sub> O <sub>3</sub> -Ga <sub>2</sub> O <sub>3</sub> -ZnO System and Related Compounds in the Ternary System- Latest Topics in Crystalline IGZO	3.0							
Systematic View of CAAC-IGZO and Other Crystalline IGZO Thin Films- Fabrication Process	3.0							
Systematic View of CAAC-IGZO and Other Crystalline IGZO Thin Films- Structural Analysis	3.0							
Systematic View of CAAC-IGZO and Other Crystalline IGZO Thin Films- Deposition Mechanism	3.0							
Systematic View of CAAC-IGZO and Other Crystalline IGZO Thin Films- Structural Stability	3.0							
Systematic View of CAAC-IGZO and Other Crystalline IGZO Thin Films- Single-Crystal and Polycrystalline IGZO	3.0							
Fundamental Properties of IGZO- Band Structure	1.5							
Fundamental Properties of IGZO- Direct Levels in IGZO Bandgaps	1.5							
Fundamental Properties of IGZO- Origin of Main Donor	3.0							
Fundamental Properties of IGZO- Electrical Conduction Mechanisms	3.0							
CAAC-IGZO Field-Effect Transistor-Electrical Characteristics of CAAC-IGZO FET	1.5							
CAAC-IGZO Field-Effect Transistor- Comparison between CAAC-IGZO and Si FETs	3.0							
Semiconducting In <sub>2</sub> O <sub>3</sub> and Ga <sub>2</sub> O <sub>3</sub>	6.0							

## Grades

Aspect	Percent
Midterm Exam	30%
Homeworks and course project	30%
Final Exam	40%

## Representative Textbooks and Other Course Materials

Title	Author
<i>Physics and Technology of Crystalline Oxide Semiconductor CAAC-IGZO: Fundamentals</i>	Noboru Kimizuka, Shunpei Yamazaki

## ABET-EAC Criterion 3 Outcomes

<b>Course Contribution</b>		<b>College Outcome</b>
**	a	An ability to apply knowledge of mathematics, science, and engineering.
*	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
	c	An ability to design a system, component, or process to meet desired needs.
	d	An ability to function on multi-disciplinary teams.
**	e	An ability to identify, formulate, and solve engineering problems.
	f	An understanding of professional and ethical responsibility.
**	g	An ability to communicate effectively.
	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
	i	A recognition of the need for, and an ability to engage in life-long learning.
	j	A knowledge of contemporary issues.
	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

**Prepared by:** Hongping Zhao