
# Bilkent EEE Distinguished Seminar Series

## Bilkent University - Department of Electrical and Electronics Engineering

## $Ga_2O_3$: Quantum Semiconductor Materials Science and Their Applications

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Gallium oxide ($Ga_2O_3$) has drawn much attention due to its potential for realizing next generation ultra-wide band gap (UWBG) electronic/optoelectronic device applications such as high-power transistors or ultraviolet (UV) solar blind photodetectors (SBPD). Of five possible different polymorphic forms (α-, β-, γ-, δ-, and κ), single crystal β-$Ga_2O_3$ exhibits a relatively high breakdown voltage compared with those of other wide bandgap materials, such as GaN or SiC. In addition, alloying with other elements such as indium, aluminum or magnesium allows for band gap engineering within the ultraviolet C light (UVC) solar blind band (200–280 nm). These potential advantages, along with the presence of commercially available single crystal substrates, have drawn considerable interest in utilizing β-$Ga_2O_3$ in many important technological applications from transparent electrodes, thin film transistors and gas sensors to solar blind photodetectors and light-emitting diodes (LED) emitting in UVC band. However, a major drawback of $Ga_2O_3$ till present has been lack of a method to obtain p-type conduction. This is a key limitation for its adoption in a whole range of semiconductor device applications.
We demonstrated how by MOCVD growth of $Ga_2O_3$ on sapphire substrate, the high levels of shallow acceptor p-type conduction could be achieved in $Ga_2O_3$ layers using silicon impurity doping under Ga rich growth conditions.1-5 This talk will present the recent advances and future trend related to science and technology of $Ga_2O_3$ based materials and their application in UVC region.

**Bio:** Manijeh Razeghi received the Doctorate d'état ES Sciences Physiques from the Université de Paris, France, in 1980. She joined Northwestern University, Evanston, IL, as a Walter P. Murphy Professor and Director of the Center for Quantum Devices in Fall 1991, where she created the undergraduate and graduate program in solid-state engineering. She has authored or co-authored more than 1000 papers, more than 34 book chapters, and 20 books, including the textbooks Technology of Quantum Devices (Springer Science Business Media, Inc., New York, NY U.S.A. 2010) and Fundamentals of Solid State Engineering, 4th Edition (Springer Science Business Media, Inc., New York, NY U.S.A. 2018). Two of her books, MOCVD Challenge Vol. 1 (IOP Publishing Ltd., Bristol, U.K., 1989) and MOCVD Challenge Vol. 2 (IOP Publishing Ltd., Bristol, U.K., 1995), discuss some of her pioneering work in InP-GaInAsP and GaAs-GaInAsP based systems. The MOCVD Challenge, 2nd Edition (Taylor & Francis/CRC Press, 2010) represents the combined updated version of Volumes 1 and 2. She holds more than 60 U.S. patents and has given more than 1000 invited and plenary talks. Her current research interest is in nanoscale optoelectronic quantum devices. Dr. Razeghi is a Fellow of MRS, IOP, IEEE, APS, SPIE, OSA, Fellow and Life Member of Society of Women Engineers (SWE), Fellow of the International Engineering Consortium (IEC). She received the IBM Europe Science and Technology Prize in 1987, the Achievement Award from the SWE in 1995, the R.F. Bun shah Award in 2004, IBM Faculty Award 2013, the Jan Czochralski Gold Medal in 2016, the 2018 Benjamin Franklin Medal in Electrical Engineering, and many best paper awards. She is an elected life-Fellow of SWE, IEEE, and MRS.