High-Temperature Electronics Course

Full-Day – Sunday – 7 July 2019 – Oxford, U.K.

First announcement

Course Description

High-Temperature Electronics (HTE) is a valuable option for improving overall system performance. Operating temperature may be thought of as an additional design parameter when justified by system requirements.

Applications of HTE include many areas: petroleum and geothermal wells, ground vehicles, aircraft, Solar System exploration, and electric power. Relocating electronic subsystems to high temperature can improve overall system efficiency, decrease size and weight, simplify maintenance and improve reliability. At the same time there are many technical challenges, related to materials and their interactions, component behavior, circuit design and interfacing.

The focus of this course is semiconductor electronics at high temperatures: device behavior, applications, advantages and drawbacks, technical issues and present situation. Basic materials characteristics related to electronics at high temperatures, and passive electronic component behavior are included, as well as assembly, packaging and interconnection. The temperature range covered in this course extends from +125°C upward, as high as 1000°C. Depending on the temperature range, HTE semiconductor devices may be based on Si, SiGe, GaAs, SiC, GaN, C (diamond) and other materials.

Although future developments in electronics are difficult to predict, it is likely that high-temperature electronics will find increased use for enhanced performance in extreme environments.

Course Objectives

Provide an overview of situations where the technologies of electronics and high temperatures are brought together.

Provide an overview of the applications for high temperature electronics.

Survey the relationships between fundamental phenomena, materials behavior, and device and system characteristics and performance at high temperatures.

Overview the behavior and technology of materials and components used in electronics at high temperatures: metals, ceramics, plastics, passive components, semiconductor materials and devices, and electronic circuits and assemblies.

Provide practical information on materials, devices, circuits and techniques for those involved in high-temperature electronics.

Printed course materials will be provided: slide handouts (approx 350 slides), supplementary course notes (approx 200 pages), plus references/bibliography (approx 800 items).

OUTLINE

(The topics may be given in a different order or organization from this outline.)

I. - Introduction and definitions, course description and objectives, temperature ranges, background.

II. - Applications: oil and geothermal wells, aircraft and automobiles, space exploration, power systems. Reasons for high-temperature operation of electronics; benefits and drawbacks.

III. - Materials behavior (semiconductors): carrier generation, mobility, electrical conductivity, freeze-out, trapping and hot-carrier effects, behavior and capabilities of Ge, Si, SiGe, GaAs, GaN, SiC, BN, C (diamond), etc.

IV. - Semiconductor device temperature capabilities/limits.

V. - Silicon device and circuit behavior at high temperatures: diodes, bipolar transistors, FETs (JFETs, MOSFETs, etc.), power devices (MOSFETs, IGBTs, thyristors, GTOs, MCTs, BMFETs, etc.), integrated circuits (bipolar, CMOS, SOI, power).

VI. - Devices and circuits based on medium-bandgap semiconductor materials: GaAs, AlGaAs, GaP, etc.

VII. - Devices and circuits based on wide-bandgap semiconductor materials: GaN, AlN, BN, SiC, C (diamond).

VIII. - Semiconductor device and integrated circuit metallizations for high temperatures.

IX. - Materials behavior (non-semiconductors): thermal conductivity, thermal expansion, heat capacity, thermal diffusivity, electrical conduction, strength, temperature capabilities, dielectric properties, magnetic properties.

X. - Passive components (resistors, capacitors, inductors), wire, connectors, switches, and batteries for high temperatures.

XI. - Assemblies for high temperatures: thin-film, thick-film, die-attach, wirebonding, soldering, packaging, interfacing, examples of assemblies.

XII. - Modeling and simulation.

XIII. - Reliability and aging: how high temperature differs from room temperature, mechanical stress, failure rates, temperature cycling studies, adaptive circuitry.

XIV. - Radiation effects and examples.

XV. - Design issues and techniques: choosing components, factors, temperature/temperature range, lifetime requirements, environment and additional stresses, resources, custom vs commercial, techniques for parts layout, circuits, ICs.

XVI. - Commercial components for high-temperature use.

XVII. - Alternative technologies for high-temperature electronics.

XVIII. - References and bibliography

WHO SHOULD ATTEND?

Engineers and technical persons involved in research or development of electronics for high-temperature applications. Managers who are overseeing high-temperature development projects. Familiarity with electronic devices and circuits is an advantage; however, relevant materials and device properties will be reviewed.

BIOGRAPHY OF PRESENTER

Dr. Randall Kirschman is an internationally recognized authority on extreme-temperature electronics. He has been consulting to industry, government and academe since 1980 in the areas of microelectronic materials and technology, and electronics for extreme temperatures.

Before going into business for himself in 1982, he managed the processing laboratory at the R&D Center at a division of Eaton Corporation, where he was responsible for the fabrication of thin-film hybrids for microwave components. Prior to that he was on the staff of the Jet Propulsion Laboratory, performing research on semiconductor materials and devices. During 1990-1991 he was a Visiting Senior Research Fellow at the Institute of Cryogenics, University of Southampton, England. and between 1998-2005 was a member of the Physics Department at Oxford University. He edited the 1999 IEEE Press/Wiley book *High-Temperature Electronics*.

He completed his undergraduate studies at the University of California, and earned his Ph.D. in Physics and Electrical Engineering at the California Institute of Technology in 1972.

www.ExtremeTemperatureElectronics.com

PRACTICAL DETAILS

Date

Sunday, 7 July 2019

Schedule

8:30 am to 12:30 pm: class, including 15-minute break with refreshments

12:30 pm to 1:30 pm: hot buffet lunch (included)

1:30 pm to 5:30 pm: class, including 15-minute break with tea

Location & Venue

Oxford, venue to be arranged

Prices

$540 or the equivalent in € or £ (full-time students $360 or the equivalent in € or £). If there are two or more enrollees from the same organization, they will each receive a 10% discount. Enrollment deadline for these prices is 7 June 2019; prices for registration after this date or on-site registration will be increased by 20%.

Payment may be made in US$, Euros, or GB Pounds, by bank transfer or check, made out to Randall Kirschman, address below.

Course price includes

Printed handouts sheets of the slides, approximately 350 slides

Extensive printed *Course Notes*, approximately 200 pages,

Bibliography/references list of approximately 800 items,

Morning break with refreshments, hot buffet lunch, afternoon tea.

REGISTRATION FORM

I wish to enroll in the **High-Temperature Electronics** course, 7 July 2019 in Oxford, UK. I agree to the following policies: If enrollment is insufficient by 7 June 2019 the course may be cancelled. The course organizer reserves the right to cancel the course for any reason and provide a full refund. Cancellation by an enrollee after 7 June 2019 or non-attendance will be subject to a non-refunded administrative charge of $60/50€/40£. A cancellation notice must be made in writing.

Name:

Organization:

Address:

E-Mail:

______ Regular: $540 or equivalent in € or UK£

______ Full-time student: $360 or equivalent in € or UK£

______ 10% discount each for two or more enrollees from the same organization.

______ 20% surcharge for registration after 7 June 2019 or for on-site registration.

Signature Date

Mail with check to

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USA
Tel/fax: +1-650-962-0200 (e-mail or phone before sending a fax)
E-mail: ExtElect@gmail.com

Or enquire for bank transfer.