

10. Diamond for Heterogeneous Integration

Course Leader: Joana Mendes - Universidade de Aveiro

Course Description:

Enhanced power density in 3D/2.5D integrated systems has led to a significant increase in the complexity of thermal management. In fact, thermal issues systems are increasingly moving to the forefront as a major challenge limiting the overall electrical performance and reliability of components in 3D/2.5D integrated systems. The thermal integrity of future heterogeneously integrated systems will not be achieved unless problems related to material features are addressed. This course will discuss the potential of integrating synthetic diamond in complex SiPs to improve heat extraction and increase reliability. The methods for fabricating synthetic diamond will be described and their pros and cons discussed. Different strategies that can be employed to integrate diamond in the concept of 3D/2.5D integration will be proposed and a critical assessment of the expected technical challenges and possible solutions will be made. Recent research work and breakthroughs from both industry and academia will be presented. Finally, the recent trend of gemstone market saturation and the impact on the cost of synthetic diamond will be discussed. NOTE: a video of a much-shorter version or segment is available on IEEE.tv (<https://r6.ieee.org/scv-eps/?p=3189>)

Course Outline:

1. Potential of Synthetic Diamond for Thermal Management Applications
2. Methods for Fabricating Synthetic Diamond, Advantages and Limitations
3. Integrating Synthetic Diamond at Different Levels in a SiP
4. Diamond for Thermal Management: Successful Examples
5. GaN HEMTS: Diamond Substrates and Diamond Capping
6. Semiconductor Disk Lasers: Diamond Sub-mounts and Heat Spreaders
7. High Power Components: Diamond Boards and Die-carriers
8. Bonding of Diamond and Non-diamond Wafers
9. Microfluidics Using Diamond
10. Current Issues and Guidelines for Solutions
11. Foreseen Synthetic Diamond Market Trends

Who Should Attend:

Researchers and practitioners looking for thermal management solutions for heterogeneously integrated packaging should attend. Managers considering the use of alternative approaches to thermal problems will also benefit from attending.

Bio: Joana Catarina Mendes graduated in Electronics and Telecommunications Engineering in 1998 and obtained her PhD degree in 2006 from the University of Aveiro, Portugal. During her PhD she studied the electrical properties of diamond films grown by chemical vapor deposition. From 2006 to 2012 she worked as researcher at the Mechanical Engineering Department in the same University and fabricated carbon-based nanostructured material composites and diamond films for tribological applications. In 2012 Dr. Mendes joined Instituto de Telecomunicações in Aveiro, Portugal, where she has been working towards integrating artificial diamond at package and system levels for improving the thermal management of optoelectronic device and systems. Dr. Mendes participated in several national and international research projects, both as Principal Investigator and team member. She has served as reviewer for several international journals. She was Chair of the 2023 and 2024 editions of IEEE Signal and Power Integrity workshop and

is a permanent member of WOCSDICE (Workshop on Compound Semiconductor Devices and Integrated Circuits held in Europe) Steering Committee. She is the author or co-author of more than 60 publications in peer-reviewed scientific journals and proceedings and 6 book chapters.