

Thermal Management

Course institution: **Technical University - Sofia, Department of Microelectronics**

Course author: **Slavka Tzanova**

Objective

The learners will be able to define the most appropriate method of design and packaging of different microsystems for effective heat evacuation and minimisation of the hot spot effect; to evaluate the reliability and to identify the possible defaults due to overheating in order to insure the reliable functioning of the microsystem.

Abstract

This course deals with effective thermal management of highly miniaturized system-on-package (SOP)-based systems. Megafunctionality, microminiaturization, multiple length scale hierarchy, multiple-functional materials, and embedded thin-film active and passive components are the essential features of SOP systems. These result in nonuniform and highly concentrated volumetric heat generation produced by a number of power sources that include not only active ICs such as microprocessors, power amplifiers, and memory devices but also passive components such as resistors. While SOP miniaturization results in an improvement in electrical performance, cost, and some aspects of reliability, it presents unprecedented thermal challenges making the total heat flux densities at the system level very close to the device level, unlike in the current approach of discrete component-based systems. This course describes the thermal SOP concept and its thermal implications. Heat sources in SOP modules are identified, and an insight into relevant heat transfer modes is given. An overview of thermal characterization techniques is presented. In addition, this course reviews the current state-of-the-art in thermal management technology that is applicable to thermal SOP. Power minimization by efficient power management, as reviewed in this course, may mitigate the thermal SOP concerns to a certain degree.

Contents

The course covers the research and innovation in the following major topics:

- fundamentals of thermal management of microsystems;
- thermal sources in systems on package (digital SOP, RF SOP, Optoelectronic SOP, MEMS);
- fundamental heat transfer modes;
- thermal characterisation:
 - numerical methods for thermal characterisation;
 - evaluation of thermal analysis software for Microsystems;
 - experimental methods for thermal characterisation;
- thermal management technologies:
 - passive methods of thermal management (high-conductivity package materials, thermal vias, heat spreader, extended surfaces, heat pipes);
 - active methods of thermal management (liquid loops, spray cooling, thermosyphon, thermoelectric cooling, thermionic cooling etc.);
- power minimisation technologies.

Learners

The primary target groups concerned are: professionals from SMEs in electronics and microsystems, students in engineering education and vocational schools, educated but unemployed

people (e.g. engineers, physicists) looking for additional training for employment.

Prerequisite and Corequisite Knowledge

It is assumed that learners are familiar with the theoretical basis of electronic components and circuits construction and functioning, treated in the courses on

- Semiconductor Devices,
- Microelectronics,
- Digital Circuits Design,
- MCMs, Assembling and SMT,
- Electronic Measurements.

Estimated duration of the course: 25 hours