



Advanced Material and characterization techniques

Abstract

The design of competitive and efficient power electronics in drives applications is an engineering challenge. Especially the choice of the right capacitor technology and layout for the DC-link is crucial.

Aluminium electrolytic capacitors are still state of the art technology in DC-link use. Design-in goals are: high ripple current load, low cost, minimum size and life time at high temperature. The first part of this tutorial introduces the audience to the fundamental physics, materials and processes of aluminium electrolytic capacitors. Some practical examples of the analysis of real applications will be shown during the tutorial. Special emphasis is given to the selection and lifetime assessment of aluminium electrolytic capacitors. The second part of the tutorial addresses advanced microscope-based characterization techniques suitable for the investigation of power electronic components, with special focus on failure analysis of electronic components with focused ion beams (FIB).

Outline

Introduction

Thomas Ebel

Introduction into the fundamental physics, design, materials and production processes of aluminium electrolytic capacitors and characterization techniques.

Aluminium Electrolytic Capacitors for Power Electronic Application – Technology, Selection and Life Time Assessment

Thomas Ebel

The Design-in of aluminium electrolytic capacitors in power electronic circuits is requiring special knowhow of the electrical and thermal behaviour of the components. These design-in phases will be demonstrated in practical examples of the analysis of real applications. A short introduction into life time assessment of aluminium electrolytic capacitors is given.

Failure Analysis of Electronic Components with Focused Ion Beams

Serguei Chiriaev

Focused ion beams (FIBs) are widely used in electronics and microelectronics for a broad range of purposes including circuit modification, design debugging, mask repair, sample preparation for inspection with other tools, and many others. Among these applications, failure analysis of electronic products is of the most significant importance. This tutorial introduces basic aspects of FIB technology and instrumentation. Major emphasis is given to the advantages of



the Zeiss NanoFab He-Ion microscope as a FIB tool for localization and visualization of defects in electronic devices; on chip level, package level and circuit levels.

A short introduction is presented into the FIB instrumentation available at the SDU Sønderborg campus as well as the physics of interaction of ion beams with materials. The visualization of “hidden” structures with ion-beam milling and imaging of defects with He FIB and synergy with X-ray micro-CT imaging will be shown.

Instructors

Thomas Ebel received his diploma and PhD degree in solid state chemistry from the University of Münster in 1992 and 1995, respectively. From 1995 to 2001 he was an R&D engineer, later R&D Director for the Aluminum Electrolytic Capacitor Division of Siemens Matsushita Components (later Epcos, now TDK) in Heidenheim. In 2001, he was delegated as an R&D Director, later CTO to BECROMAL SpA in Milano, Italy, a manufacturer of foils for aluminium electrolytic capacitors. From 2008 to 2018, he was an R&D Director and later managing Director of FTCAP GmbH in Husum, Germany, a manufacturer of aluminium electrolytic and metallized film-capacitors. Since summer 2018, he is Head of the Electrical Engineering Section and CIE (Centre for Industrial Electronics) at SDU, Denmark, where he is associate professor working on design and analysis of passive components (capacitor) for drives, with particular interest in renewable energies and electric vehicles.

Serguei Chiriaev received his MSc. degree in solid state physics from Belorussian State University, and his PhD degree in physics and mathematics from Belorussian Academy Science in 1975 and 1984, respectively. In 2008, he accomplished the entrepreneurship development programme at Massachusetts Institute of Technology in Cambridge (USA). Between 1975 and 1991 he worked as a senior research scientist at Belorussian State University on synthesis and processing of electronic materials. He has spent five years at the Institute of Physics and Astronomy, Aarhus University (Denmark) with a research focus on semiconductor device fabrication technology. From 1998 to 2014 he worked as an R&D specialist at different divisions of Danfoss A/S in Nordborg, Denmark. His activities in this period spanned microtechnology, physical and chemical sensors, and microfluidic systems. He is currently an associated professor at the Mads Clausen Institute, SDU, Denmark, where his research interests include electronic materials technology, and application of FIBs in imaging and nanofabrication.