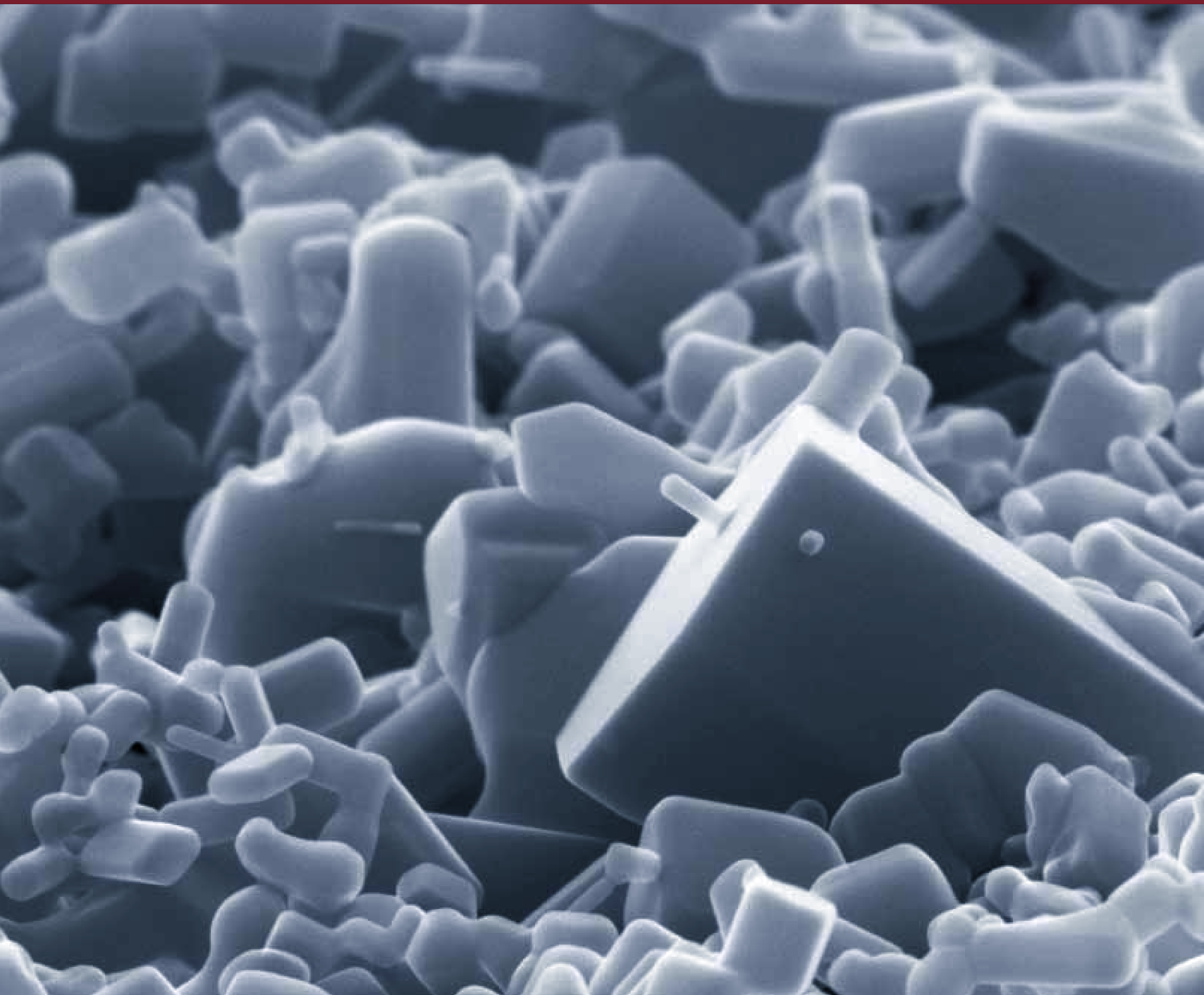
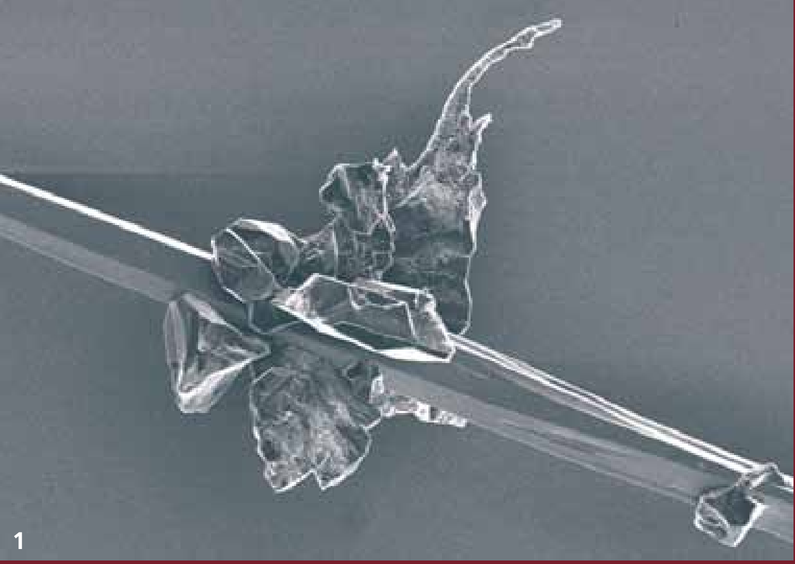
Fraunhofer IISB

FRAUNHOFER-INSTITUT FÜR INTEGRIERTE SYSTEME UND BAUELEMENTETECHNOLOGIE IISB

MATERIALS FOR ELECTRONICS

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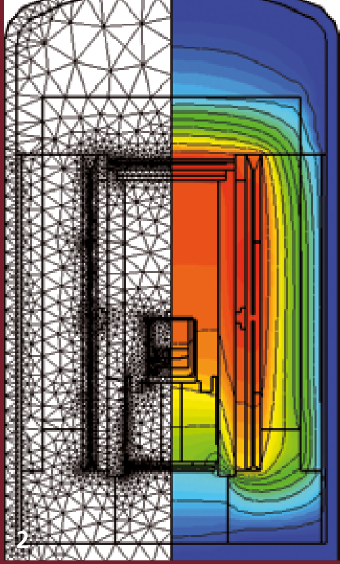
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MATERIALS FOR ELECTRONICS

Continuous miniaturization, performance, and cost pressure are characterizing the development of micro and nanoelectronics as well as of power electronics. Reliability and life time issues and a massive extension of functionalities and fields of application require perpetual innovation. Thereby, new materials with tailored properties play a key role for the further development of advanced electronics.
Tailored materials for electronics are a core topic for the Fraunhofer Institute for Integrated Systems and Device Technology IISB, which as a partner of industry conducts applied research and development and offers services – among others – in the following areas:

Optimized Semiconductor Materials

High-quality semiconductor crystals are an essential basis for high-performance micro and nanoelectronics and efficient photovoltaics. Fraunhofer IISB focuses on the development and optimization of crystal growth furnaces and processes with regard to the size and especially the quality of these crystals. The special strength of Fraunhofer IISB is the combination of experimental analyses, metrology, and computer simulation, investigating heat and species transport, chemical reactions, and defect formation. The crystal growth activities of Fraunhofer IISB include the following materials:

- Silicon for microelectronics and photovoltaics
- Low-defect compound semiconductors (III-V, II-VI)
- Silicon carbide (homoepitaxial layers)
- Optical crystals (e.g., oxides, fluorides)
- Metallic alloys

Ultra-thin Layers for Nanoelectronics

Conductor, semiconductor, or dielectric – modern electronics is based on ultra-thin layers of functional materials, consisting of only a few atomic layers up to several microns. Fraunhofer IISB is dealing with layer characterization and the assessment of alternative materials, as well as with the manufacturing methods and equipment for controlled deposition, covering the following materials and techniques:

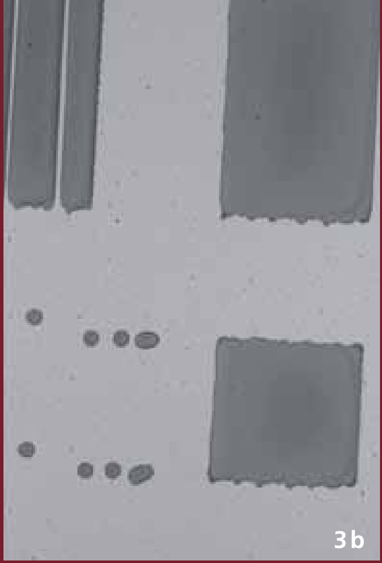
- Dielectrics (high-k)
- Metal electrodes
- MOCVD, ALD, PVD

1 *Semiconductor crystals: Harmful impurities in a silicon crystal for photovoltaics; silicon nitride needle with silicon carbide precipitations.*

2 *Simulation: Temperature field in a crystallization furnace for photovoltaic silicon, computed by the IISB software „CrysMAS“.*

3 *Printed electronics: The interaction of ink and substrate is essential for the formation of structures.*
a *Printing of a silver nanoparticle dispersion on an untreated organic insulator.*
b *Printing of a silver nanoparticle dispersion on surface-optimized silicon dioxide.*

COVER PAGE
Zinc oxide nanocrystals for printed electronics.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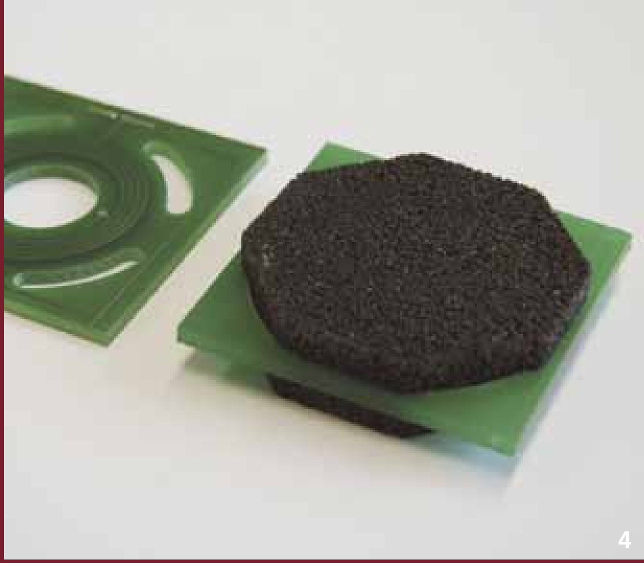
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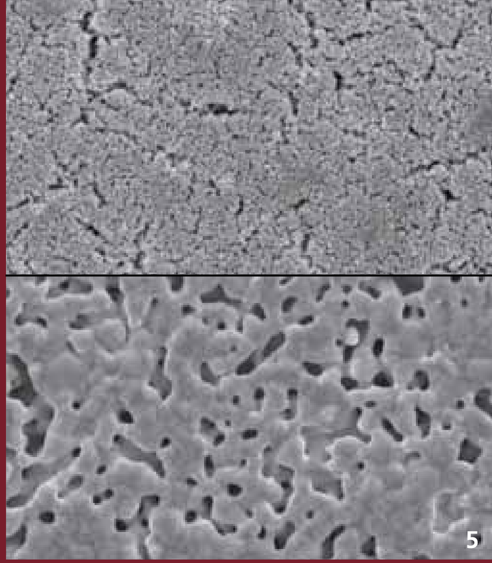
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Printable Inorganic Electronics

For the combination of everyday products with simple electronic functions, the cost factor plays an essential role. Fraunhofer IISB does research on the realization of printed electronics on the basis of inorganic nanoparticles. For this purpose, a special laboratory which allows the printing of electron devices by ink-jet techniques was established. The work of Fraunhofer IISB includes the following aspects:

- Synthesis of functional nanoparticles and ink development
- Printing techniques and material integration
- Realization of switching, memory, and sensor functionalities
- Electron devices and applications

4 *Power electronics: Circuit-board-integrated transformer with soft-magnetic polymer compound as core material.*

5 *Power electronics: Layer of silver nanoparticles before and after sintering.*

Materials for Power Electronics

Power electronics has to be compact, robust, and safe. Fraunhofer IISB develops new power electronic devices and systems (e.g., for application in electric cars) as well as material designs and processing technologies. The competencies of Fraunhofer IISB cover:

- Silicon carbide (devices, processing, e.g., high-temperature annealing)
- Soft-magnetic polymers based on powder, polymer compounds (e.g., passive devices)
- Development of die-attach techniques, e.g., sintering of silver nanoparticles
- Reliability testing of interconnect techniques, e.g., wire bonds, high-temperature solders, conductive adhesives

Simulation and Characterization of Material Properties

For the development of modern electron devices and semiconductor manufacturing processes, the use of computer simulation is indispensable. This also includes crucial aspects of materials science. Fraunhofer IISB investigates synthesis, deposition, structuring, doping, and defect formation. Physical and chemical properties of the materials and structures are related to the manufacturing parameters with the goal of optimizing the resulting electron devices.

Experimental analysis and characterization of new materials play an important role, either. Fraunhofer IISB is dealing with layers, substrates, media, and environmental materials used in manufacturing with respect to quality, physical-chemical properties, modification, and contamination. For that purpose, the institute provides a broad range of analysis methods and develops in-situ metrology and advanced process control.

CONTACT

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