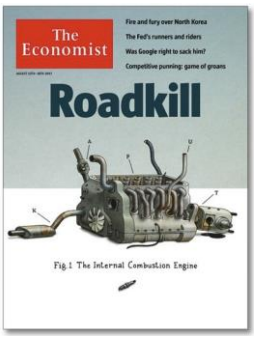
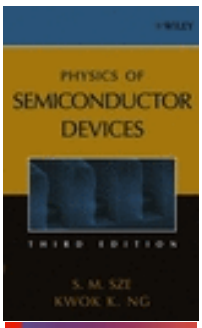
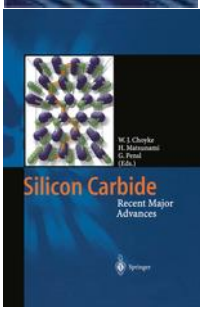
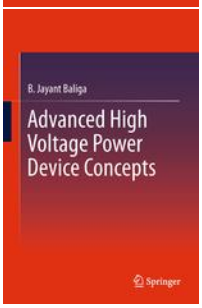
	Modul	**STAND: 07.03.2019**
1	Modulname	*Energy-Efficient Power-Semiconductor Architectures and Technology*
2	Kürzel	EEPSAT
3	Leistungspunkte (LP)	3
4	Semesterwochenstunden (SWS)	2,0
5	Moduldauer (Anzahl der Semester)	1
6	Turnus	jedes 2. Semester, SS
7	Sprache	Deutsch, Unterrichtsmaterial in englischer Sprache
8	Modulverantwortliche/r	Prof. Dr.-Ing. Joachim Burghartz Institut für Nano- und Mikroelektronische Systeme (INES)
9	Dozenten	Dr. sc. nat. Holger Bartolf Automotive Electronics, Robert Bosch GmbH, 72762 Reutlingen. E-Mail: holger.bartolf@de.bosch.com
10	Verwendbarkeit/ Zuordnung zum Curriculum	Elektro- und Informationstechnik, Master, Wahlmodul
11	Voraussetzungen	Kenntnisse im Umfang der Vorlesungen (B. Sc.): Mikroelektronik, Halbleitertechnik, Halbleitertechnologie
12	Lernziele	Die Studierenden haben ein umfassendes Verständnis des Designs von Energie-effizienten Halbleiter-Architekturen unter Miteinbeziehung von Aspekten der Prozesstechnologie um das Verständnis der kosteneffizienten Produktionsmethoden für Hochvolumina von Halbleiterchips mit hoher Qualität und Zuverlässigkeit zu fördern. Der Fokus wird auf das Material Silizium Carbid (SiC; ein sogenannter WBG Halbleiter) und dessen Schlüsselrolle in der Elektromobilität gelegt.
13	Inhalt	**Die Vorlesung beinhaltet die folgenden Fokusthematiken:** • **Semiconductors**: Si vs. SiC **Industrialization**: Comparison: Material, Timeline. • **Bulk Growth** of **SiC** (and Si). • Device **Manufacturing Technology**. • Unipolare und Bipolare Limits (the impact of the WBG). • **Charge Compensated** and **Charge-Coupled** Designs. • Energy-Efficient, Failure Robust **Power Rectifiers in SiC**. • **Unipolar Power MOSFETs**: MOS-interface physics; ultra-brief: V,D,U-MOS architectures. Si: SC, CC, SJ, GD-CC architectures. SiC: planar, AccuFET, deep p^{++}-plug architectures: 1, 2. • **Unipolar Power JFETs** and **Cascodes.** • **Bipolar Switches**: BJTs, Thyristors, IGBTs. • **Dynamic Behaviour**: Switching and Failure Mechanisms.
14	Literatur/Lernmaterialien  	**Aus der Zeitung (siehe links):** • **The death of the *internal combustion engine***: In August 2017 the cover story in *The Economist* announced, "*The death of the internal combustion engine... it had a good run. But the end is in sight for the machine that changed the world.*". In a remarkable account, *The Economist* reports that the internal combustion engine's "*days are numbered. Rapid gains in battery technology favour electric motors instead. ... Today's electric cars, powered by lithium-ion batteries, can do much better.*" Left: *The Economist's* August 12th -18th issue from 2017 titles the *dawn of a new era of mobility*; Facts: see *e.g.* until 2016, 2017.







Grundlagen zu Halbleitern (Fokus Leistungshalbleiter):

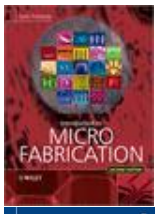
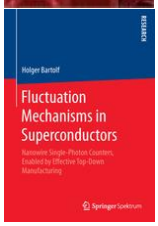
- S. M. Sze, Kwok K. Ng, ***Physics of Semiconductor Devices***, 3rd edition, John Wiley & Sons: New Jersey, United States of America, 2007, https://onlinelibrary.wiley.com/doi/book/10.1002/0470068329.
- S. Linder, ***Power Semiconductors***, 1st edition, CRC Press: Lausanne, Switzerland, 2006, https://www.crcpress.com/Power-Semiconductors/Linder/p/book/9780824725693.
- B. J. Baliga, ***Fundamentals of Power Semiconductor Devices***, 2nd edition, Springer: New York, United States of America, 2019, https://www.springer.com/us/book/9783319939872.
- J. Lutz, H. Schlangenotto, U. Scheuermann, R. De Doncker, ***Semiconductor Power Devices: Physics, Characteristics, Reliability***, 2nd edition, Springer: New York, United States of America, 2018, https://www.springer.com/us/book/9783319709161.
- H. Bentarzi, ***Transport in Metal-Oxide-Semiconductor Structures***, 1st edition, Springer: Berlin Heidelberg, Germany, 2011, https://www.springer.com/us/book/9783642163036.

Grundlagen zu Silizium Carbid:

- T. Kimoto, J. A. Cooper, ***Fundamentals of Silicon Carbide Technology: Growth, Characterization, Devices, and Applications***, 1st edition, John Wiley & Sons: New Jersey, United States of America, 2014, https://onlinelibrary.wiley.com/doi/book/10.1002/9781118313534.
- W. J. Choyke, H. Matsunami, G. Pensl, ***Silicon Carbide: Recent Major Advances***, 1st edition, Springer: Berlin Heidelberg, Germany, 2004, https://www.springer.com/us/book/9783540404583.
- P. Friedrichs, T. Kimoto, L. Ley, G. Pensl, ***Silicon Carbide: Volume 1: Growth, Defects, and Novel Applications,*** 1st edition, John Wiley & Sons: New Jersey, United States of America, 2011, https://onlinelibrary.wiley.com/doi/book/10.1002/9783527629053.
- P. Friedrichs, T. Kimoto, L. Ley, G. Pensl, ***Silicon Carbide: Volume 2: Power Devices and Sensors,*** 1st edition, John Wiley & Sons: New Jersey, United States of America, 2011, https://onlinelibrary.wiley.com/doi/book/10.1002/9783527629077.
- S. E. Saddow, A. K. Agarwal, ***Advances in Silicon Carbide Processing and Applications,*** 1st edition, Artech House, Inc.: Norwood, United States of America, 2004, http://us.artechhouse.com/Advances-in-Silicon-Carbide-Processing-and-Applications-P775.aspx.

Spezialliteratur zu "*Power Semiconductor Architectures*":

- B. J. Baliga, ***Advanced Power Rectifier Concepts***, 1st edition, Springer: New York, United States of America, 2009, https://www.springer.com/us/book/9780387755885.
- B. J. Baliga, ***Advanced Power MOSFET Concepts***, 1st edition, Springer: New York, United States of America, 2010, https://www.springer.com/us/book/9781441959164.
- B. J. Baliga, ***Advanced High Voltage Power Device Concepts***, 1st edition, Springer: New York, United States of America, 2012, https://www.springer.com/us/book/9781461402688.

	 	**Prozesstechnologie:** • S. Franssila, ***Introduction to Microfrabrication***, 2nd edition, John Wiley & Sons: New Jersey, United States of America, 2010, https://onlinelibrary.wiley.com/doi/book/10.1002/9781119990413. • Teile der Prozesstechnologie werden gelesen aus: H. Bartolf, ***Fluctuation Mechanisms in Superconductors: Nanowire Single-Photon Counters, Enabled by Effective Top-Down Manufacturing***, 1st edition, Springer-Spektrum: Wiesbaden, Germany, 2016, https://www.springer.com/us/book/9783658122454.
15	Lehrveranstaltungen und Lehrformen	*Energy-Efficient Power-Semiconductor Architectures and Technology*, Vorlesung, 2,0 SWS
16	Abschätzung des Arbeitsaufwandes	Präsenzzeit: 22.5 Stunden Selbststudium: 67.5 Stunden Summe: 90.0 Stunden
17a	Studienleistungen (unbenotet)	
17b	Studienleistungen (benotet)	Prüfung „*Energy-Efficient Power-Semiconductor Architectures and Technology*“, mündliche Prüfungen, 45 Minuten.
18	Grundlage für ...	
	Zusatzinformationen (optional)	
19	Medienform	Tafel, Powerpoint
20	Bezeichnung der zugehörigen Modulprüfung/en und Prüfnummer/n	
21	Import-Exportmodul	von: nach: