SiC high-temperature electronics – is this rocket science?

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After 20 years of development, silicon carbide (SiC) has reached maturity and commercial availability in the form of high-voltage discrete rectifiers (1200 and 1700 V junction barrier Schottky diodes) and switches (1200 and 1700 V MOSFETs, JFETs, and BJTs) from several suppliers. It has long been known that SiC is also a semiconductor capable of high temperature operation, since its intrinsic temperature is around 1000 °C. Several groups have demonstrated SiC devices, circuits and sensors working at 300–600 °C. At KTH we have established a bipolar process for integrated circuits in SiC that can operate at 300 °C without failure [1]. With bipolar electronics any electronic function can be built (sensors, analog-to-digital converters, power controllers, radio electronics, and digital electronics) so we are confident that any electronic system needed, including MEMS, could be implemented with our technology.

SiC also has higher radiation tolerance compared to silicon (10–100x), which could be crucial in space missions where several types of radiation exist. One of the closest planets to explore is Venus. The surface of Venus is of scientific interest because of its seismic and volcanic activity, whereas the atmosphere is also interesting, as it consists largely of carbon dioxide, but the large amounts of sulfuric acid is highly challenging for a lander. Since the surface temperature of Venus is around 460 °C the electronics in a Venus lander must be able to withstand these temperatures for an extended time. The electronics of previous Venus landers in the Soviet Venera series 9–14 in the 1970's lasted only hours [2]. The purpose of this presentation is to propose electronics for a system capable of providing a breakthrough in planetary sciences: collection of data from the surface of Venus over extended time.

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1. L. Lanni, R. Ghandi, B. G. Malm, C.-M. Zetterling, and M. Östling, "Design and characterization of high-temperature ECL-based bipolar integrated circuits in 4H-SiC", *IEEE Trans. Electron Dev.* **59**, 1076 (2012).
2. *http://en.wikipedia.org/wiki/Venera*
3. *http://www.hotsic.se*