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Innovative thermo-electrical generators based on the Seebeck effect

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Abstract

Internet of Things (IoT) is becoming the new driver for semiconductor industry and the largest electronic market ever seen. The number of IoT nodes is already many times larger than the human population and is continuously growing. It is thus mandatory that IoT nodes become self-supplying with energy harvested from environment since periodic exchange of batteries in such a huge number of units (often located in inaccessible places e.g. industrial environment or elements of constructions) is impractical and often simply impossible. Photovoltaic generators may easily harvest energy where light is available, but the IoT nodes often work in dark, hidden locations where the only available energy sources are heat losses. There, thermoelectric generators (TEGs) could be the best candidate, if not that if we speak of exploiting heat losses it often means very low temperature differences. This corresponds to the conditions where TEGs power production drops down dramatically. In this presentation we will review our long date efforts of improving TEGs and rendering them commercially viable.

We have put forward a new idea of TEG's pulse operation that boosts the power production up to X2.7. This extends the domain of applicability of TEGs to lower temperature differences, where conventional TEGs are out of the game. We will show that the improvement X2.7 maintains also at larger temperature differences that presents obvious advantages. In addition to power generation efficiency, there are other concerns with Seebeck based TEGs. The materials they use are expensive and not environment friendly. For 15 years we have been studying the Seebeck effect on Si and SiGe. We will report considerable improvements and ideas that bring Si and SiGe TEGs closer and closer to their BiTe-based counterparts. With these improvements together with pulse mode of operation, the SiGe TEGs are knocking the door of commercially viable manufacturing.

Biography of Presenting Author

Thomas Skotnicki was with France Telecom from 1985 till 1999 when he joint STMicroelectronics. He became the first STMicroelectronics Company Fellow and Technical Vice-President. He invented the UTBB FDSOI structure (in production at STMicroelectronics, GF and Samsung). Today he is the Co-Leader of the CENTERA project (International Research Agenda funded by Foundation for Polish Science) and Professor at Institute of High-Pressure Physics, and at Warsaw University of Technology, Poland. He holds 80 patents and has authored close to 500 scientific papers, and several book chapters on CMOS and Energy Harvesting. His models/software MASTAR were used by ITRS for 12 consecutive editions for calculations of CMOS roadmaps. He is an IEEE Fellow, has supervised 34 PhD theses, during 8 years served as Editor for IEEE TED, was on JJ Ebers and Frederik Philips IEEE Award Committees, and served in Executive Committees of all big conferences in his field (IEDM, Symposia on VLSI, ESSDERC, ICSICT, ECS, etc).

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