Prof. Elison Matioli - Ecole polytechnique fédérale de Lausanne

Nanoscale devices to address large-scale challenges:
from efficient power electronics to bridging the terahertz gap.

Electricity is the fastest growing form of end-use energy; however, a significant portion is wasted in power conversion. Increasing the efficiency of electrical conversion offers a vast and low-cost energy resource to address the increasing energy demand and reduce carbon dioxide emissions. Elison Matioli and his research group demonstrated groundbreaking technologies, based on the nanoscale design of devices and materials, to considerably increase the efficiency of power electronic devices, and also address other important societal challenges.

To drastically reduce energy losses in power electronics, his group demonstrated the novel concept of semiconductor devices with multiple highly-conductive channels, resulting in over 4x-smaller sheet resistances. Achieving high-voltage operation in such ultra-conductive structures was a major issue, which was addressed by their innovative concept of lateral slanted field-plates, consisting of nanostructuring regions of the device to effectively manage high electric-fields.

Second, the constant increase of power density poses another major challenge for the future of electronics: thermal management. Prof. Matioli's team demonstrated the co- design of microfluidics and electronics into the same semiconductor, to produce a monolithically-integrated manifold microchannel cooling with unprecedented performance, and demonstrate an ultra-compact integrated power converter on a single chip.

Finally, the yet underexplored Terahertz spectrum could unleash promising applications, from biological imaging to very-high-data-rate communications. Prof. Matioli's group conceived an innovative on-chip, all-electronic device based on nanoscale plasma, that enabled ultrafast switching speed, more than 10x-faster and with over 200x-greater power than the state-of-the-art compact solid-state electronics, which is a promising technology to address the so-called Terahertz gap.