University Latsis Award EPFL 2020 – Elison Matioli

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

Prof Matioli received the Latsis University Award 2020 from the EPFL

> *"For his demonstration of ground-breaking technologies, based on nanoscale design of semiconductors and other materials, to address some important societal challenges, including efficient power electronics, effective thermal management and bridging the terahertz gap. "*

Electricity is the fastest growing form of end-use energy, but a significant portion is wasted in power conversion, especially in power semiconductor devices. Prof. Matioli's group have demonstrated the novel concept of multiple highly-conductive channels, vertically stacked within the semiconductor, resulting in over 4x-smaller sheet resistances. Achieving high-voltage operation in such ultra-conductive structures was a major issue, addressed by their innovative concept of lateral slanted field-plates, consisting of nanostructuring regions of the device to effectively manage high electric-fields. This technology can significantly increase the efficiency of power devices for future power conversion applications.

A second major challenge for the future of electronics is thermal management. Prof. Matioli's team demonstrated the co-design of microfluidics and electronics into the same semiconductor, in a single manufacturing process, in which microfluidic channels are embedded inside the chip very near the device hot spots. This led to a monolithically-integrated manifold microchannel cooling, that mimics a capillary network from the human circulatory system, with unprecedented performance, enabling the demonstration of an ultra-compact power converter on a single chip with integrated cooling. This technology could offer a major impact to all types of electronics.

Finally, Prof. Matioli's groups has also contributed to the yet underexplored Terahertz spectrum, which 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. Such nanoscale design of devices and materials could have a significant impact on important societal challenges.