

**ICB PhD public presentations****MANIPULATING LIGHT IN LEDs:  
FROM EMITTER ORIENTATION TO  
ELECTROLUMINESCENT  
METASURFACES****Tommaso Marcato**

ICB/The Shih Group

Supervisor: Prof. Dr. Chih-Jen Shih

Co-examiners: Prof. Dr. Romain Quidant and  
Prof. Dr. Malte C. Gather**20/03/2024, 11:45 am****ETH Hönggerberg, HCI H 2.1 and on Zoom****(<https://ethz.zoom.us/j/67097568305> )**

**Project Summary:** Light manipulation drives key modern technologies like illumination, imaging, and data communication, with semiconductor light sources such as LEDs being fundamental components. In this project, focusing on emerging thin-film LED technologies, we develop strategies for precise control of electroluminescence properties such as directionality and polarization. First, we establish transition dipole moment engineering as a technique to enhance lead halide perovskite QLED efficiency. Our theoretical model pinpoints the role of quantum confinement, anisotropic shape, and assembly order. Leveraging these effects, we demonstrate green QLEDs achieving a record 25% external quantum efficiency. Finally, we explore arrays of organic emitter nanostructures to manipulate OLED radiation pattern and polarization. NanoOLED devices with ultrahigh pixel densities surpassing 80'000 ppi are fabricated via nanostencil lithography and shown to exhibit dual functionality as LEDs and electroluminescent metasurfaces.

**CV.** Tommaso graduated from Politecnico di Milano with a BSc in Chemical Engineering in 2017. After the completion of a MSc in Chemical and Bioengineering at ETH Zürich in 2019, he joined the research group of Prof. Chih-Jen Shih at the Institute for Chemical and Bioengineering for his PhD studies.