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## Short Course Title

MicroLEDs and other emerging display technologies: a technology, industry and market landscape

## Abstract

Following Philippe's talk about displays in Europe, this talk plans on addressing microLEDs in more details, their possible applications in displays, and all other emerging display technologies that may or may not compete with one another in the near future, in this more than profuse display field. MicroLED technology could match or exceed OLEDs for most key display attributes.

However, it is also an inherently complex technology. Manufacturing a 4K resolution display implies assembling and connecting 25 million microLED chips the size of large bacteria without a single error, with placement accuracy of 1  $\mu\text{m}$  or less.

Sony's demonstration of a full HD 55" microLED TV at CES 2012, more than six years ago, was the first exposure for microLED displays and generated a lot of excitement. Since Apple acquired Luxvue in 2014, many leading companies such as Facebook, Google, Samsung, LG or Intel have entered the game via sizable internal developments, acquisitions, like those of mLED and eLux, or investments in startups such as glō or Aledia.

MicroLED companies must understand the cost targets for each application and work backward, making process choices and developing each step so it fits the cost envelope.

Processes that can't deliver the right economics will disappear. If none can deliver the right economics, the opportunity will never materialize. MicroLED is entering the valley of death between technology development and industrialization and commercialization. As the technology improves, there are credible cost reduction paths for microLED to compete in the high-end segment of various applications such as TV, augmented and extended reality (AR/VR).

With unit sales stagnating, TV panel makers are entering what is likely to be a period of prolonged excess capacity. This translates into commoditization and shrinking profitability in an industry that is very capex-intensive. An unprecedented variety of technologies are emerging that could deliver some or all of the new advanced TV features required to stimulate demand and pricing. The leading contenders are inkjet-printed EL-QD and RGB OLEDs, with possible stop-gaps such as QD-OLED and hybrid EL-QD/OLED.

Although still an outsider, microLED is attracting increased attention since it could deliver performance equal to or better than any other technology, and enable the manufacturing of displays of any size without requiring large-size TFT substrates.

Regarding extended reality (AR/VR), and more specifically augmented reality, there is an issue on both the display and the associated optics. Current optical waveguiding combiners may be poorly efficient, but they are the only technological approach able to couple an image in and out and transmit it close to the eye without having to put bulky optical parts in the headsets. Today, AR headsets run with either OLED-on-silicon micro-displays or projection display technologies, which are not compact enough, or

do not provide enough luminance to the eye. MicroLEDs can link the best of both worlds and provide enough luminance to overcome the poor efficiency of optical wave-guiding combiners in a small form factor.

## Speaker Biography

As a technology and market analyst for the display industry, Dr. Zine Bouhamri is a member of the Photonics, Sensing and Display division at Yole Développement. Zine manages the day-to-day production of technology and market reports, as well as custom consulting projects. He is also deeply involved in business development activities for the Displays unit at Yole.

Previously, Zine was in charge of numerous R&D programs at Aledia. In his time there he developed strong technical expertise as well as a detailed understanding of the display industry. Zine is the author and co-author of several papers and patents.

Dr. Bouhamri holds a degree in Electronic Engineering from the National Polytechnic Institute of Grenoble (France), one from the Politecnico di Torino (Italy), and a PhD in Radio Frequency and Optoelectronics from Grenoble University (France).