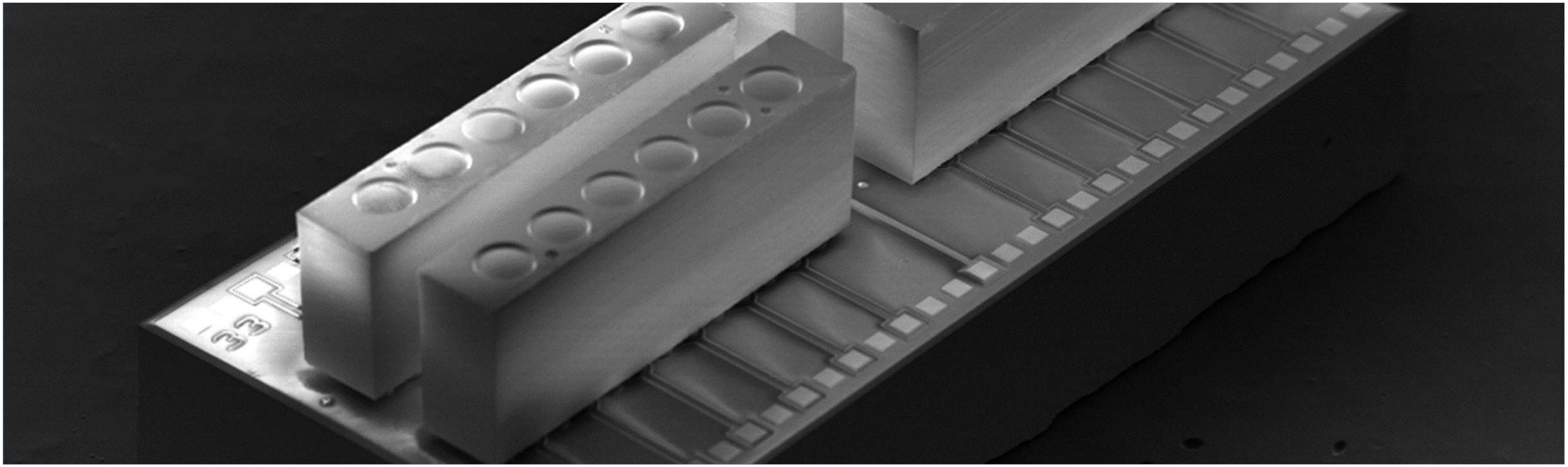


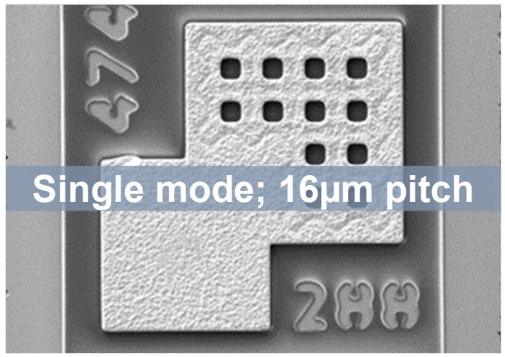
June 7th, 2021

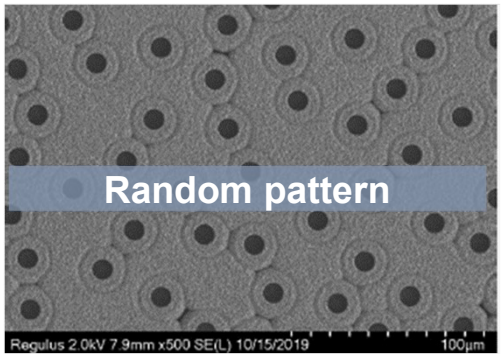
2021 EPIC Online Technology Meeting on VCSEL Manufacturing and Applications

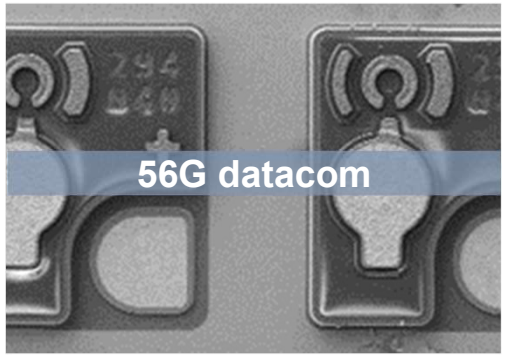
Joseph Pankert, TRUMPF Photonic Components

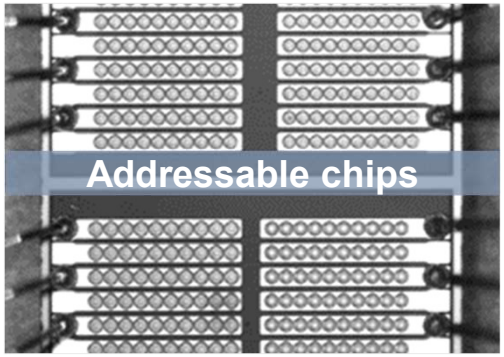
TRUMPF

Challenges we are facing today: PROCESS CONTROL



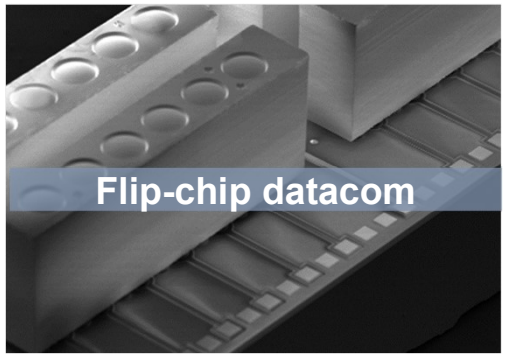


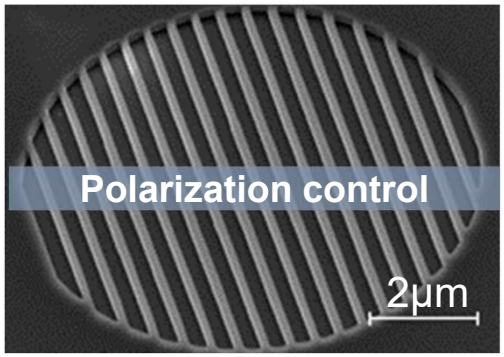


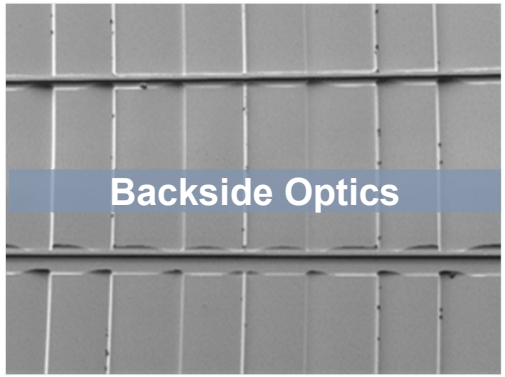


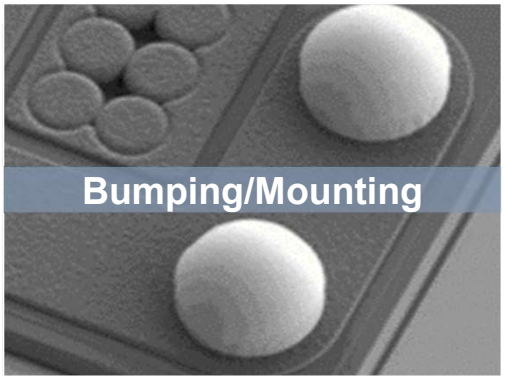
- **TRUMPF has shipped close to 2Bln VCSELs without field returns**
  - Single- and multi-mode, 760nm-1300nm, small/large/regular/irregular/addressable.. arrays, high-speed datacom,…
- **The money is**
  - 20% in Epi: adding value
  - 40% in front-end processing: adding value
  - 40% in testing and qualifying: adding cost
- **The challenge is in process control**
  - Compositional control of Epi: impossible to repair mistakes
  - Dimensional control over full 6” wafer: defining the yield
  - Target to reduce and speed up testing

Challenges we face tomorrow: FUNCTIONAL INTEGRATION



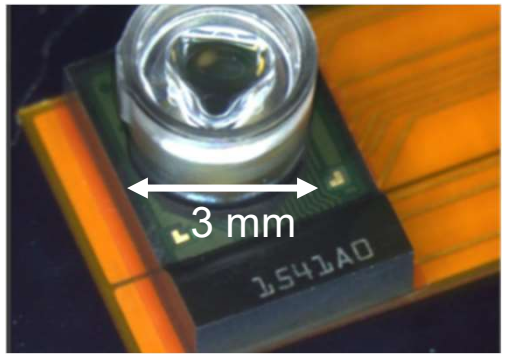


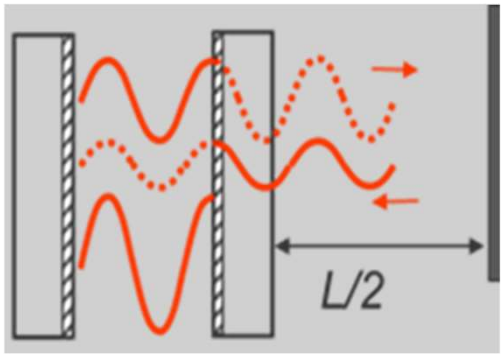


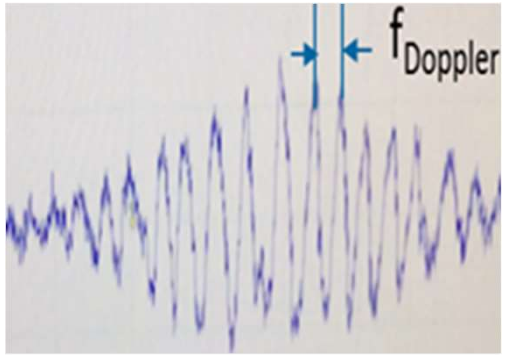


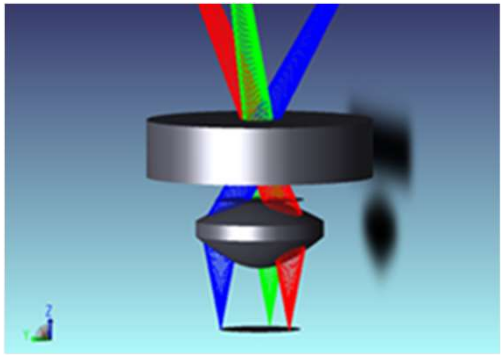
- **GaAs platform allows all kind of functional integration**
  - Lasers, LEDs
  - Photodiodes
  - (Photo)transistors
  - Passive optics (lenses, pol. gratings, diffusors, waveguides,..)
  - Chip-scale packaging
- **The challenge is the exploding complexity**
  - Process control (again!): doubling or tripling number of masks!
  - Modelling and design rules

Next challenge: EXTENDED & NEW APPLICATIONS









- **Example: PM2.5 particle measurement (in cooperation with Bosch Sensortec)**
  - Detection principle:
    - VCSEL light back-reflected from dust particles
    - Back-reflected light coherently interferes with laser beam (“self-mixing interference”)
    - Signal detection by integrated Photodiode
    - Signal processing generates PM2.5 values
  - Sensor is extremely compact and does nor require venting holes
- **Challenge for the EPIC community: INVENT!**
  - We have tapped only a fraction of what VCSEL technology can do for you

Thank you for listening!

TRUMPF is happy to engage with partners to excel in manufacturing

TRUMPF is looking forward to engage in new application fields

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