Next Generation Transceivers for Optical SatCom

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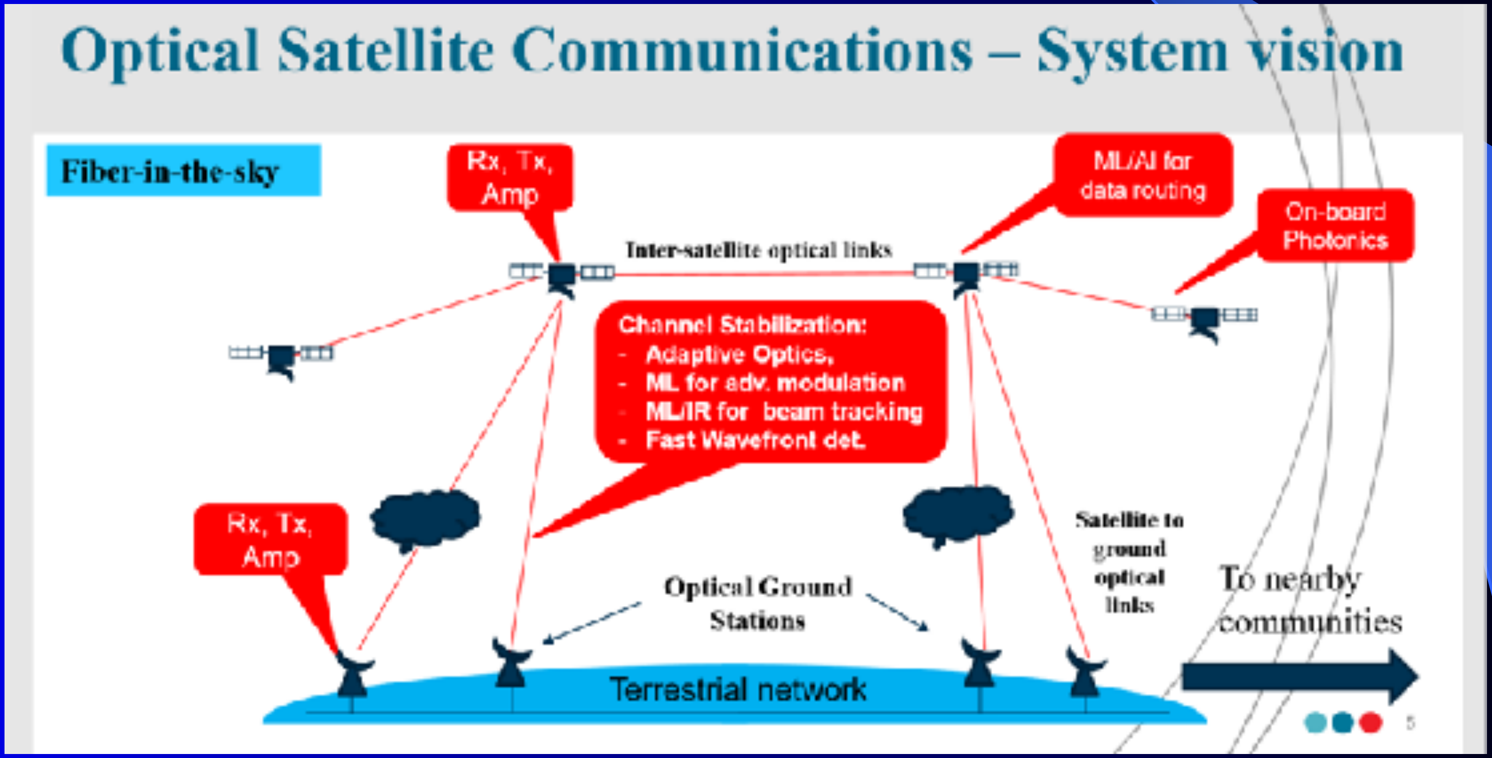
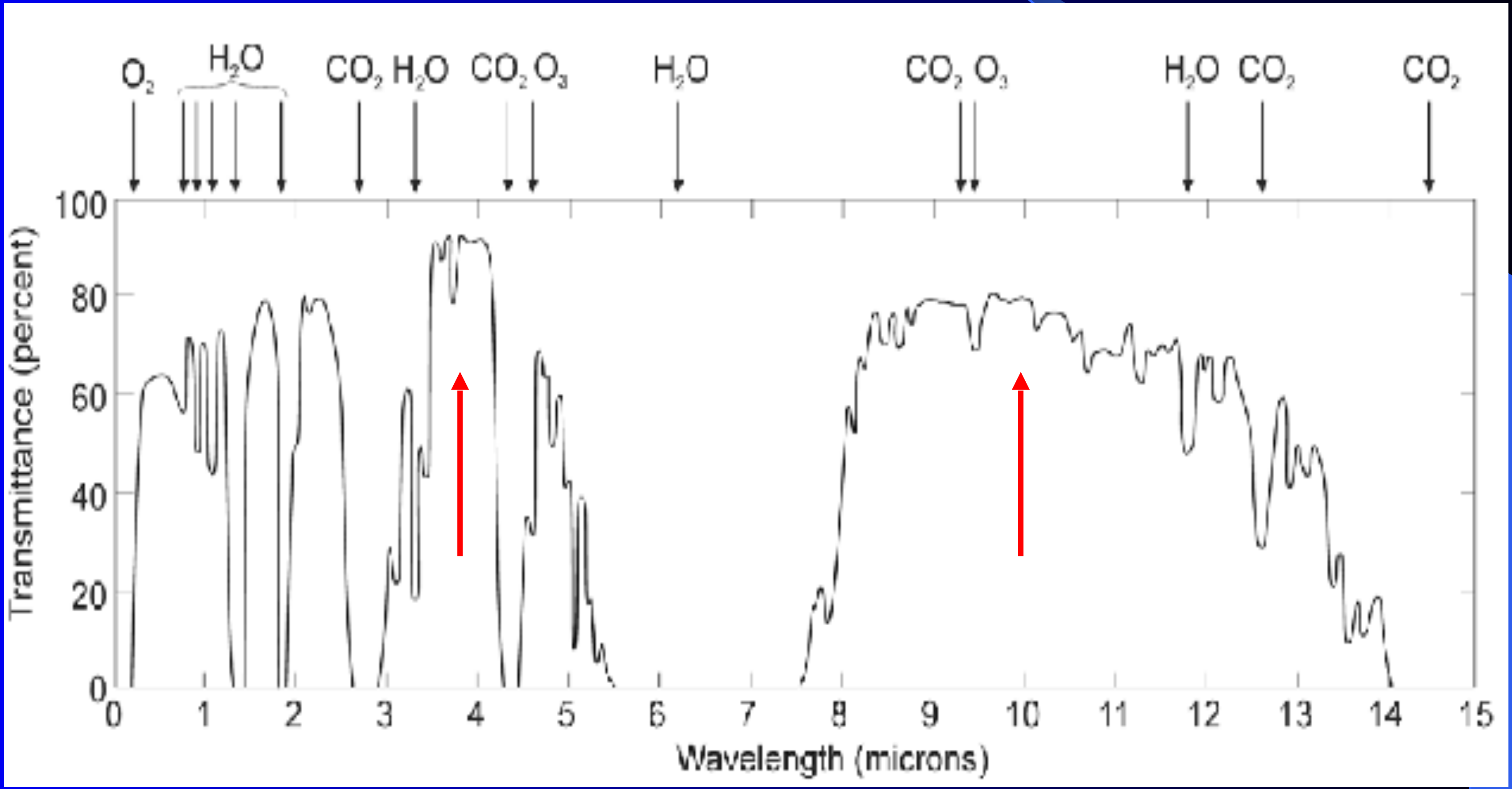
Background

- All-weather high speed optical satellite communication is necessary (especially to Canadians living in rural and remote communities)



Background – Why Mid-IR

- Laser wavelengths set in an atmospheric window have much less loss



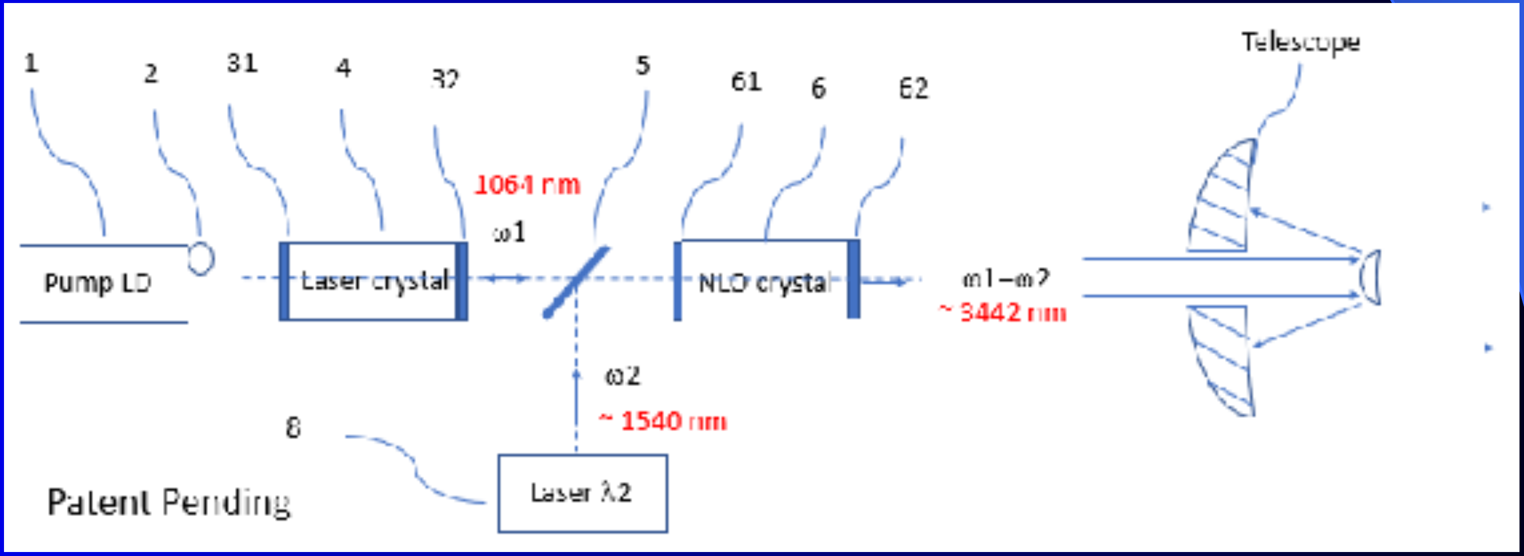
Wikipedia

Background – Issues

- Mid-IR is the best choice for all-weather OSC
  - Much less loss (absorption/scattering)
  - Much less background noise
- However, Mid-IR lasers operated at room temperature with high-speed and high-power are not available on the market.
- Most of the reported OSC systems are based on near-infrared (800 – 1550 nm) lasers, which can be modulated at high speeds (> 1 Gbps).

Our Solution: 1550 → Mid-IR

- Mid-IR laser using difference frequency generation (DFG) in a nonlinear crystal
  - Method #1: PPLN: periodically poled lithium niobite for 3-5 um
  - Method #2: QPM GaP: quasi-phase matched GaP for 8-12 um
- Taking advantages of the mature & low-cost optical and electronical components widely used in fiber tele-com



Our Solution: Perovskite lasers

- Mid-IR through down-conversion from visible to 4-5 um
  - Intense green emission from metallorganic halide perovskite nanoparticles
  - High narrow emission observed from $La_{0.7}Sr_{0.3}M_{0.1}Fe_{0.9}O_3$ (M = Mn^{2+}, Co^{2+}, or Ni^{2+}) perovskites
  - Mixed structures possible on single substrate
- Unique platform to produce nanoparticles with <2% variation in size, deposited on any surface
- approach will allow increase of Q-factor for lasing, and tuning of the range of emission wavelengths

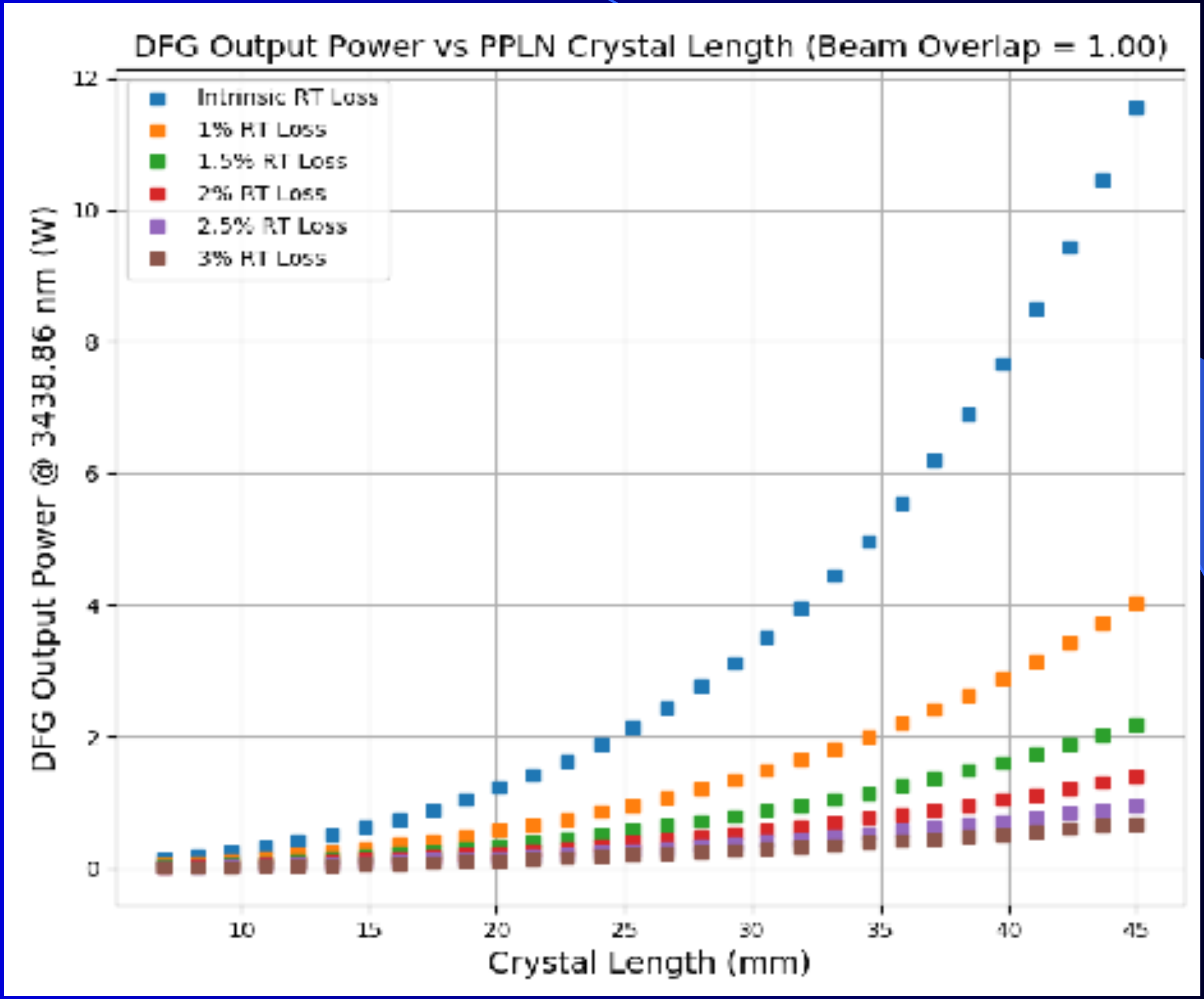
Our Team

- Chang-qing Xu
- Unique nonlinear optical device platforms established at McMaster
- ~30 years experience on PPLN

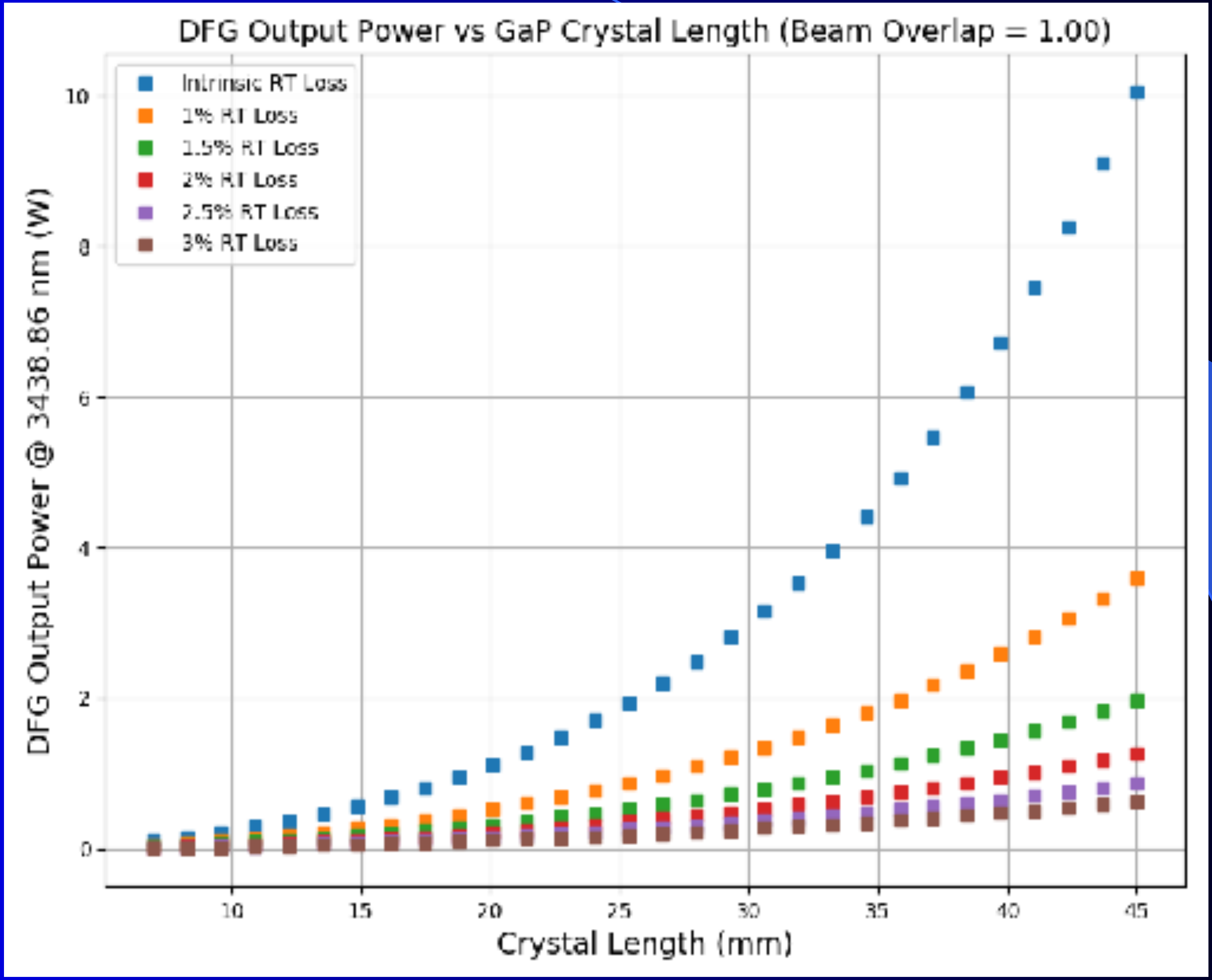
- Ryan Lewis
- MOCVD and MBE growth of III-V materials, nanostructures and optoelectronic devices at McMaster
- ~15 years experience in III-V epitaxy

- Ayse Turak
- Unique universal route to homogenous solution processed perovskite nanoparticles based on reverse micelle deposition established at McMaster
- 10 years experience in reverse micelle deposition of nanoparticles
- 20+ years in optoelectronic device design

Simulated Mid-IR Output Power - PPLN



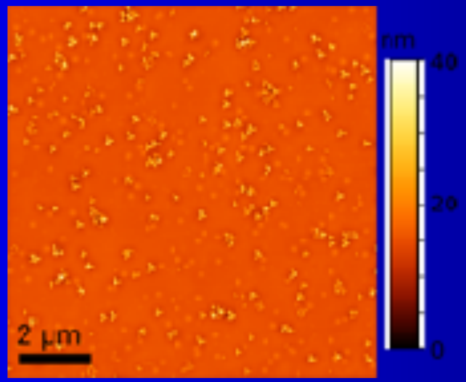
Simulated Mid-IR Output Power - GaP



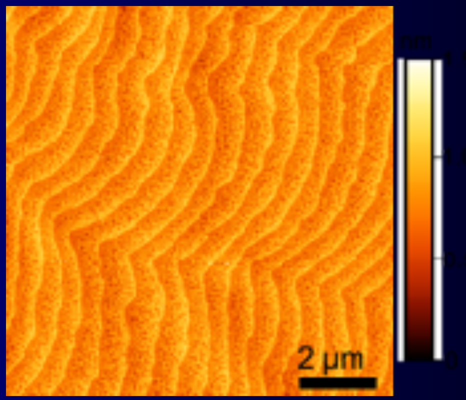
Orientation-patterned III-V materials

- Novel MOCVD GaP/Si/GaP approach under development to induce crystal inversion (Si platform compatible)
- Unconventional (111)A substrates promising for obtaining low-defect inversion
- Unique surfactant-enhanced growth developed by PIs overcomes historical challenges of (111) III-V epitaxy

Conventional GaAs growth on GaAs(111)A
→ Topographical defects

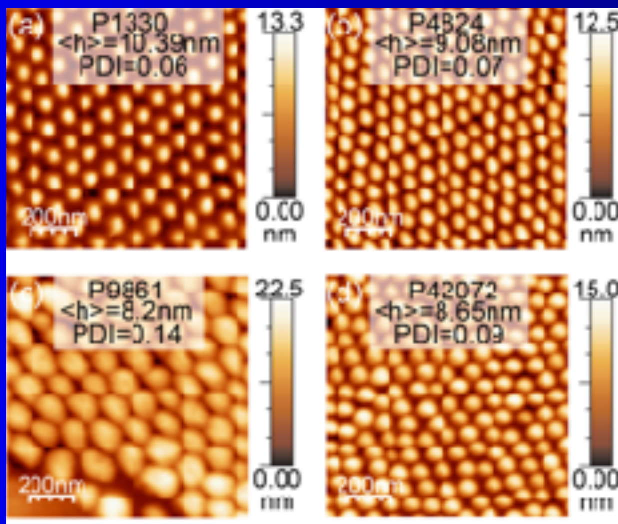


Growth with surfactant
→ Atomically smooth

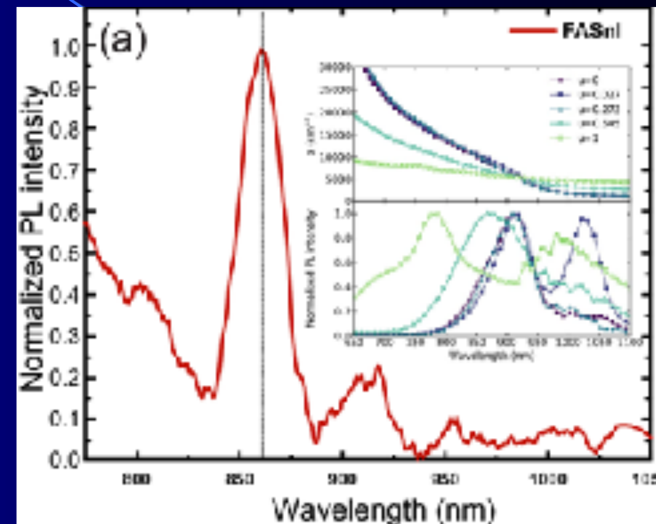


Perovskite Lasers – Progress to Date

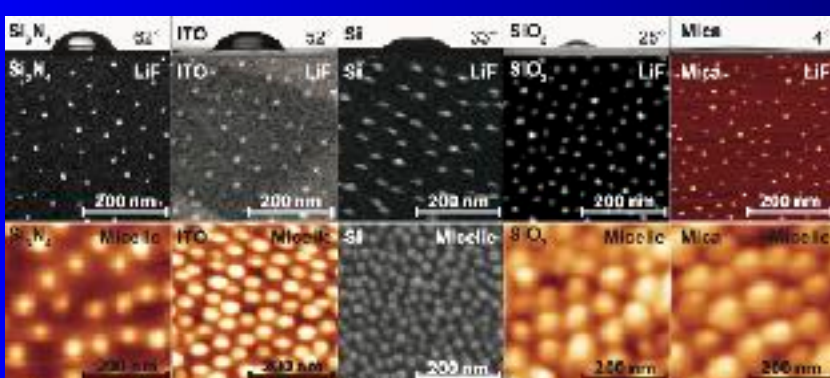
Attempting perovskite photonic crystal, whispering gallery modes, DBR, DFL approaches for optimal lasing



Produced near-IR perovskite nanoparticle emitter: FaSnI

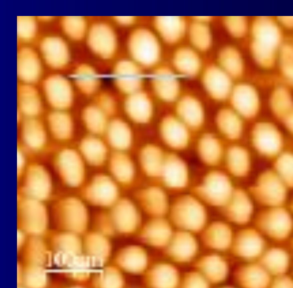


Achieved substrate independent deposition

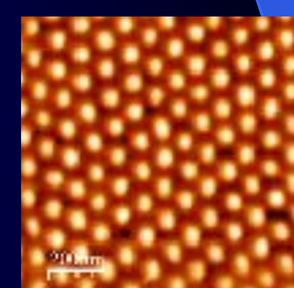


Tuned periodic to aperiodic dispersions

Toluene



o-xylene



Thank you!