Investigation of Atomic Layer Deposition for Distributed Bragg Reflector Mirror Stack

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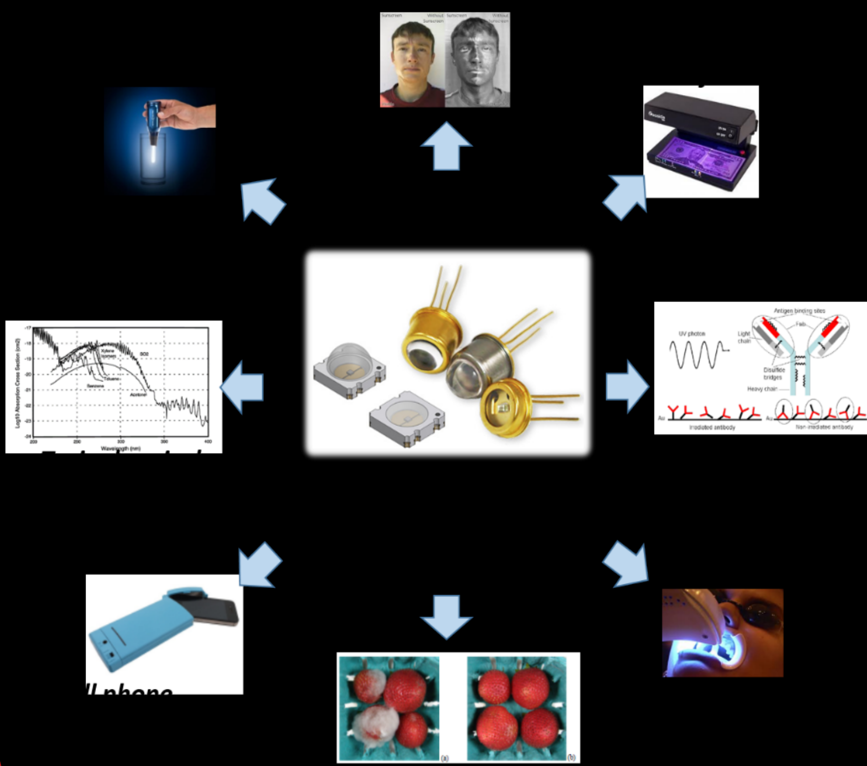
DUV LEDs

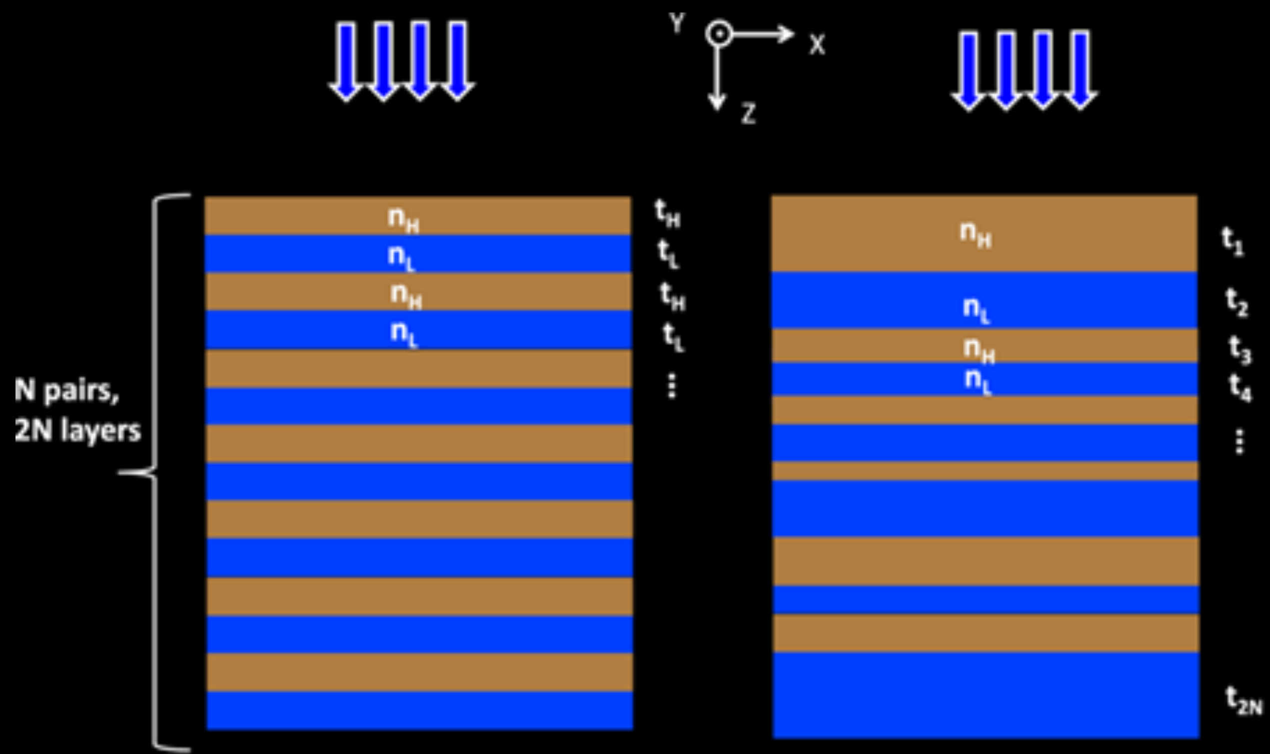
Applications



- Higher Energy, Small Wavelength
- Ability to damage DNA

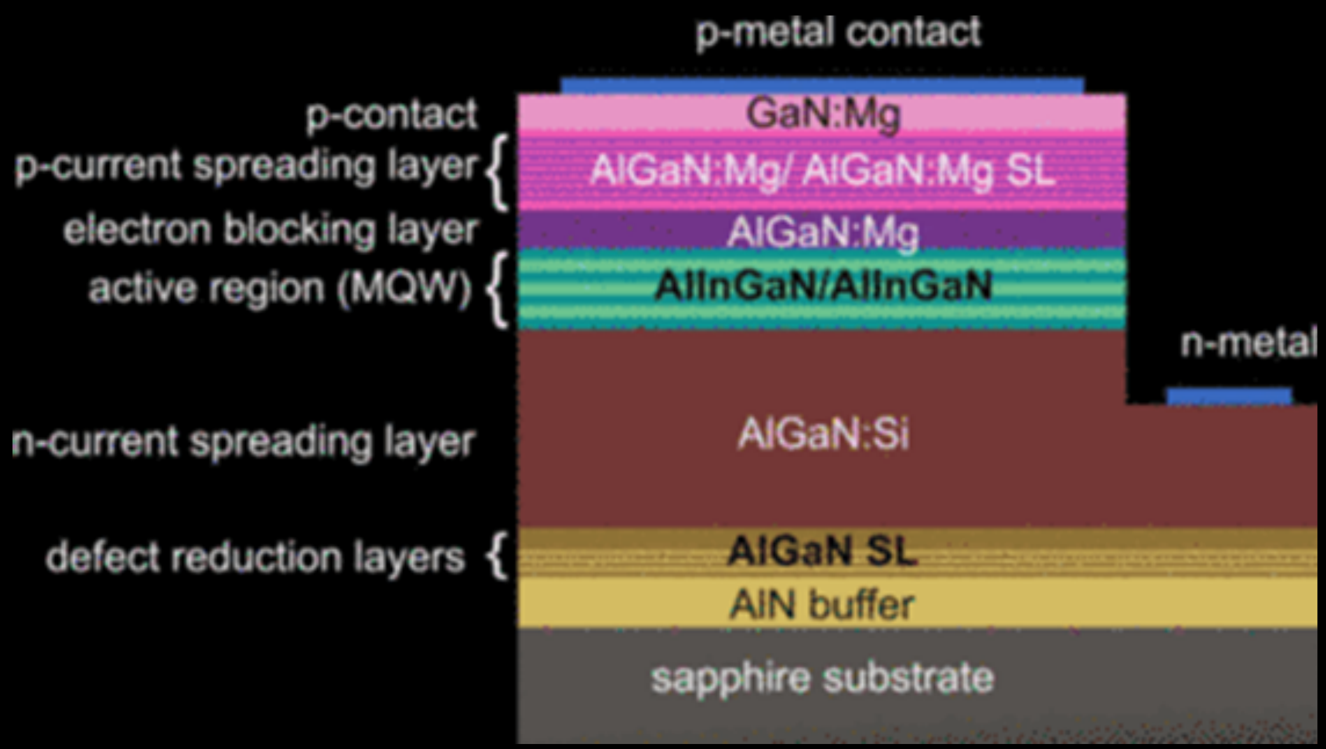
Distributed Bragg Reflector

- Alternating Layers of High and Low Indexes of Refraction
- High Bandwidth to avoid Absorption
- ¼ λ Layer Thickness to promote constructive interference



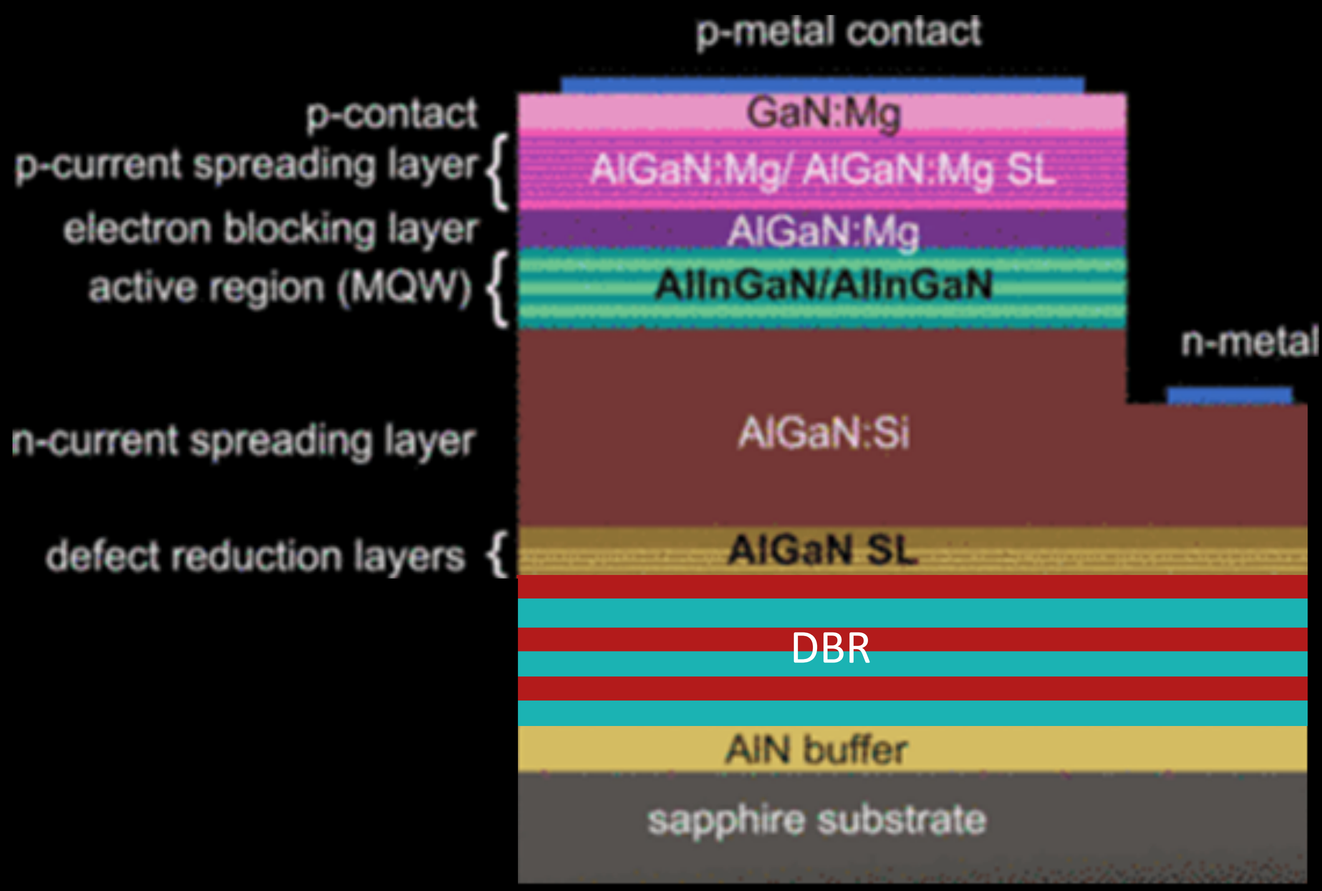
https://www.researchgate.net/figure/280063325_fig8_Periodic-and-aperiodic-distributed-Bragg-reflector-DBR-stacking-n_H-and-t_H

DUV LED Structure



http://www.laytec.de/uvled

DUV LED Structure



http://www.laytec.de/uvled

DBR Problems

- Crystal Lattice Match
- Indexes of Refraction
- Material Bandgap
- Layer Strain
- Crystal Quality
- Ultrasmooth Surface
- Layer Profiles
- Process Compatibility

Methods

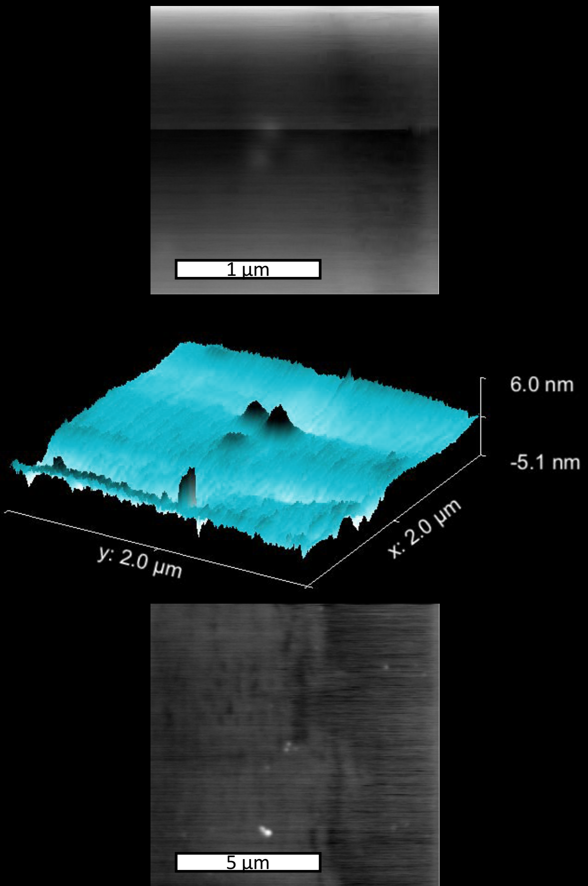
- Molecular Beam Epitaxy (MBE) [Most Common]
- Chemical Vapor Deposition (CVD)
- Metalorganic Vapor Phase Epitaxy (MOVPE)
- Atomic Layer Deposition (ALD)

Goal

- Explore viability of ALD has a method of building DBRs for DUV LEDs

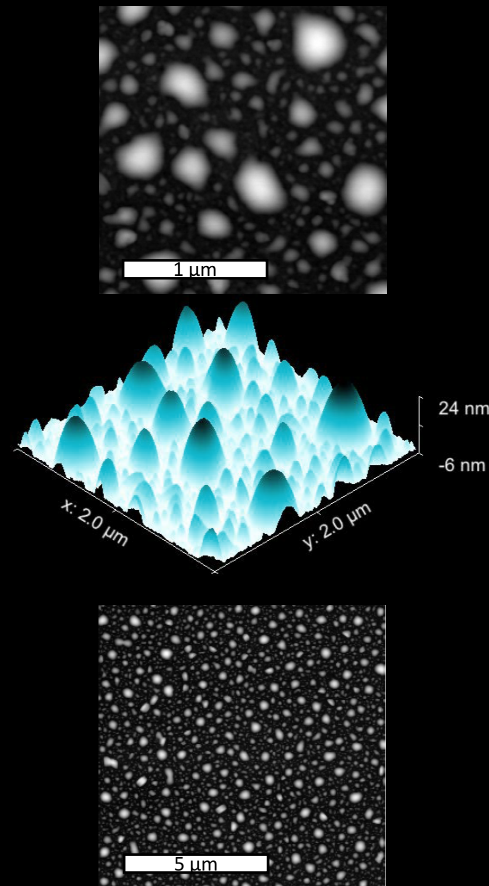
Ultrasmooth Surfaces

Al_2O_3 300°C



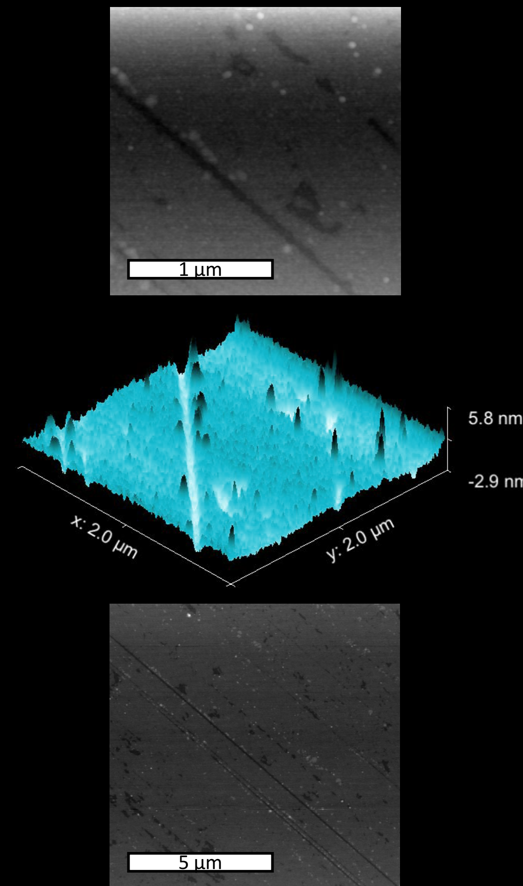
0.7nm RMS Roughness

AlN 300°C



1.0nm RMS Roughness

Ta_2O_5 300°C



0.1nm RMS Roughness

Growth Time

Growth Technique	MBE	ALD
Growth Rate of ALN (nm/hour)	200	20

ALD Crystal Quality

- Hard to match crystal structure
- Considered poor relative crystal quality
- Amorphous

Pros

- ✓ Ultrasmooth surfaces
- ✓ Highly precise thickness accuracy
- ✓ Substrate compatibility
- ✓ New type of materials
- ✓ Low Temperature
- ✓ High Conformity

Cons

- Very Slow
- Relatively Poor Crystal
- Lattice Matching Problems

Conclusions

- ALD has potential to be used for DBRs in some cases but faces many obstacles to be viable.

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