Inorganic-Organic Hybrid Perovskites

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Inorganic Materials - Seshadri

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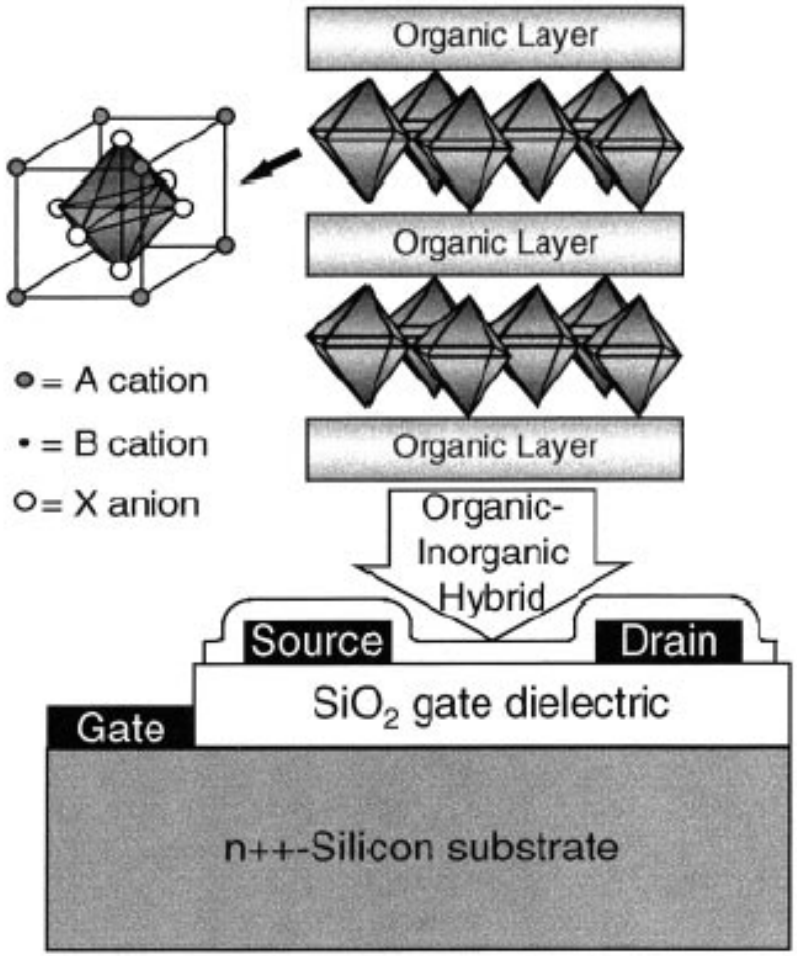
Hybrid Perovskites

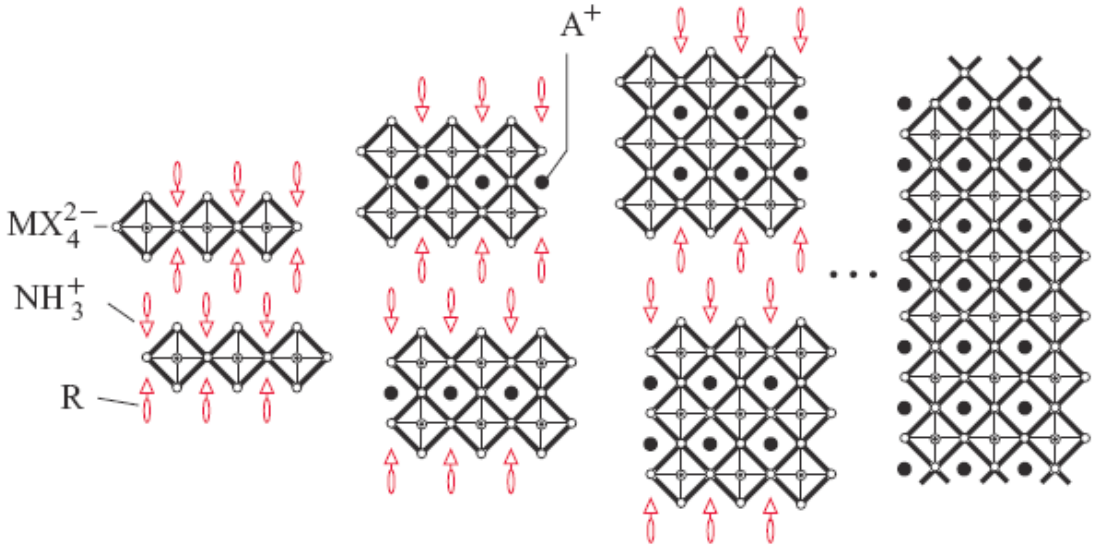
- **Interest**
  - Unique physical properties
  - Applications in technology
  - Ease of processing
  - Tunability
  - Flexibility
  - Low Cost

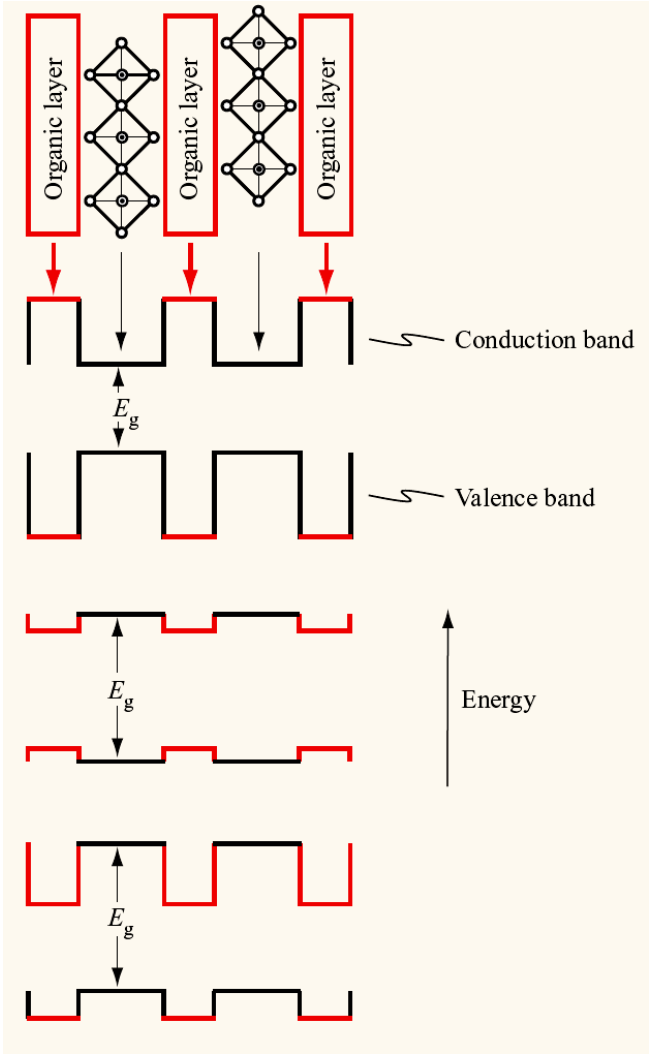


Kagan et. al., *Science* **286**, 945-947 (1999)

Crystal Structure

- Perovskite-based
  - Series of corner-sharing octahedron
  - Band gap structure
  - Electron transport in layered material

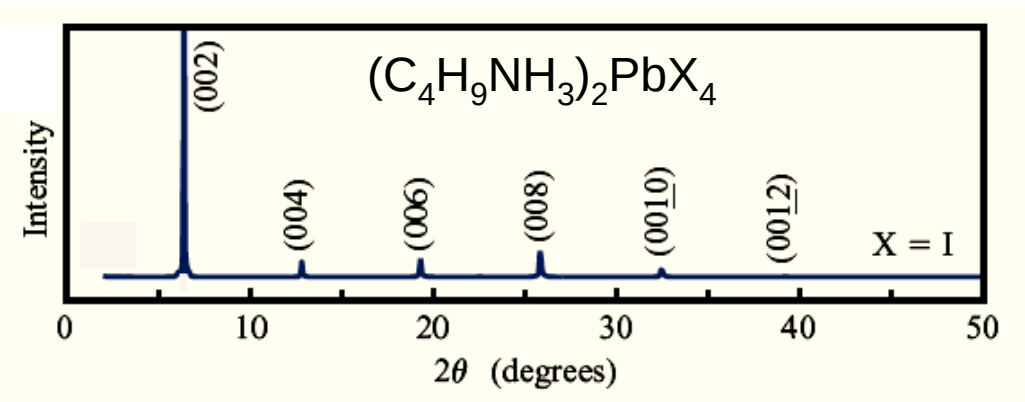


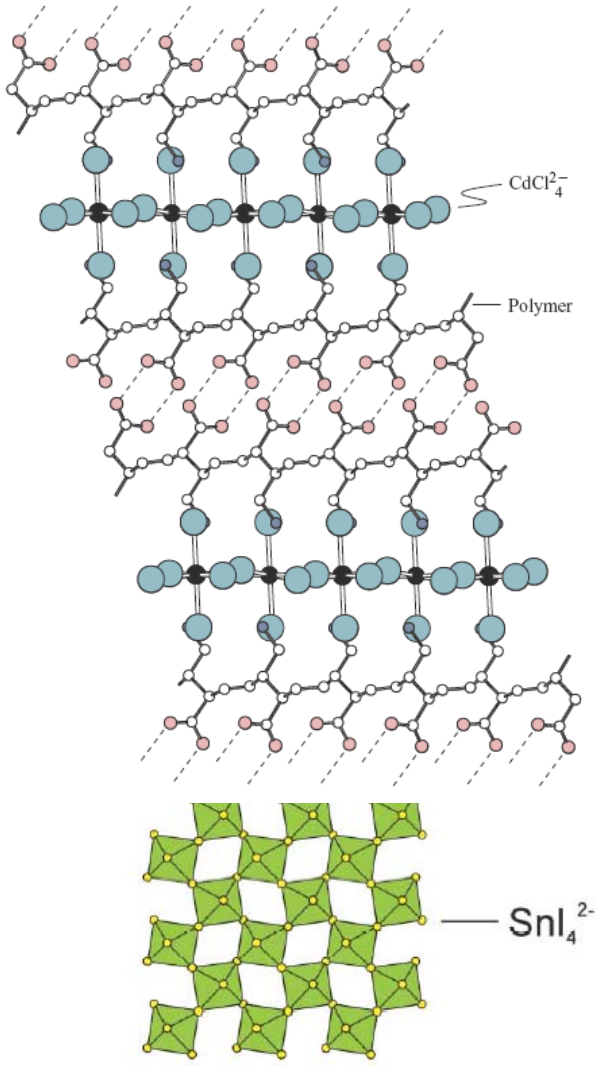


Mitzi et. al., *IBM J. Res. & Dev.* **45**, no. 1 (2001)

Structural Characteristics

- **Inorganic:** M^{2+} and halides
  - Dimensionality
  - Semiconductor, metallic, magnetic
  - Symmetry and vacancies
- **Organic:** Protonated Amines
  - Hydrogen bonding, vdW, stacking
  - Intercalation
  - Shape constraints



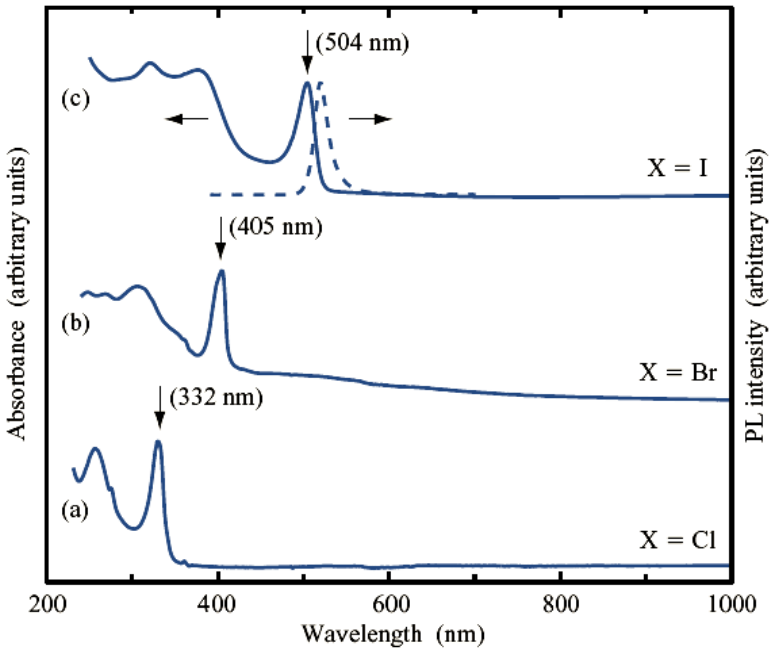


Mitzi et. al. *J. Mater. Chem.* **14**, 2355–2365 (2004)

Inorganic Layers

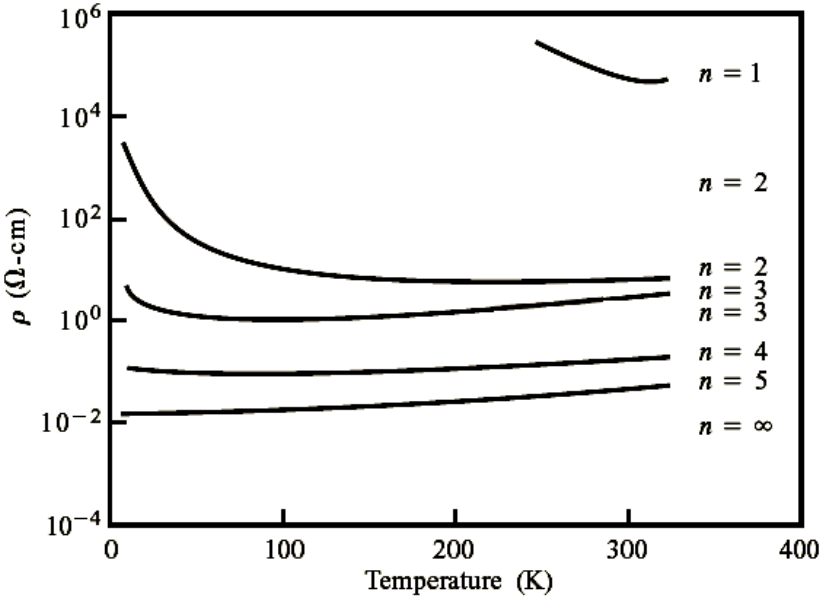
- Band gap series

$(C_4H_9NH_3)_2PbX_4$



- Conductivity

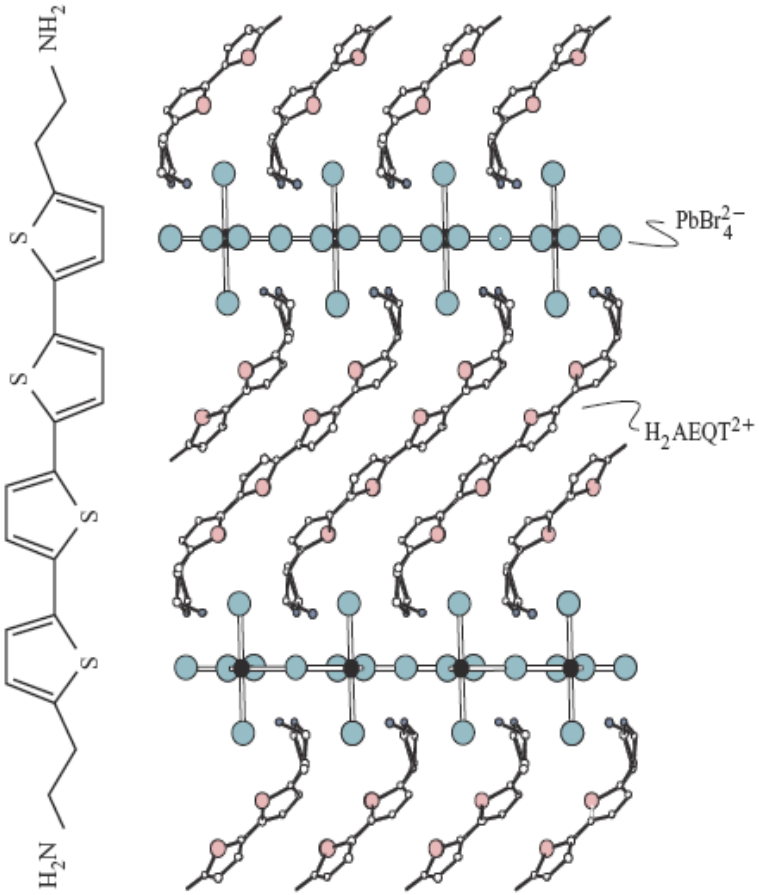
$(C_4H_9NH_3)_2(CH_3NH_3)_{n-1}Sn_nI_{3n+1}$



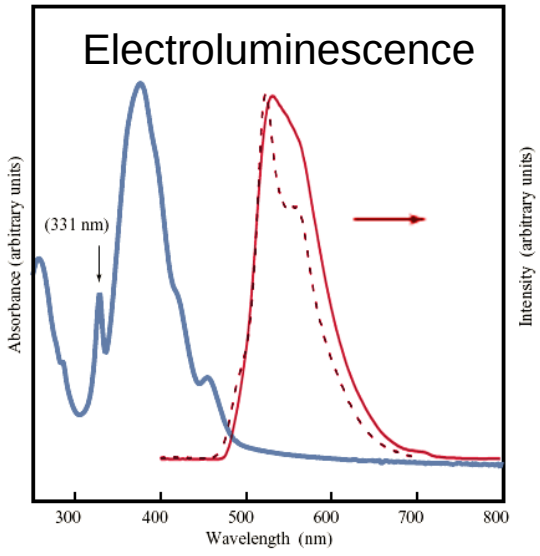
Mitzi et. al., *IBM J. Res. & Dev.* **45**, 1 (2001)

Organic Layer

$(H_2AEQT)PbCl_4$



- Organic-Inorganic LEDs
- Polymerization reactions
- Structure/mobility
- Perturbations of structure due to confinement

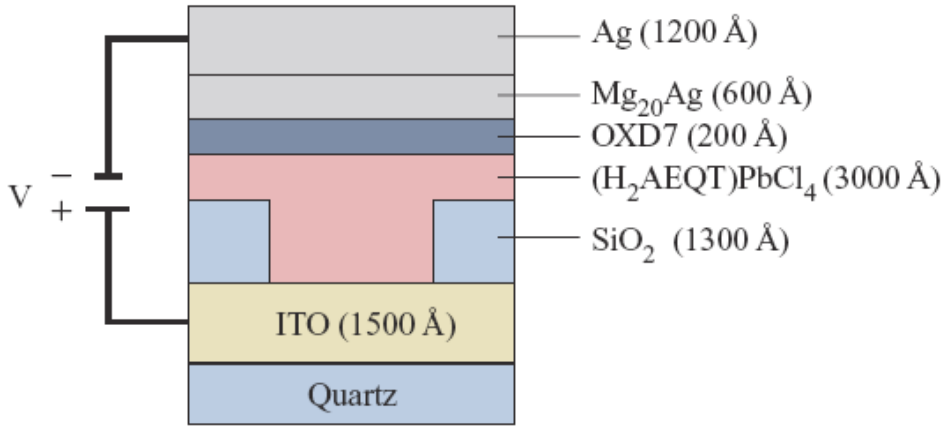


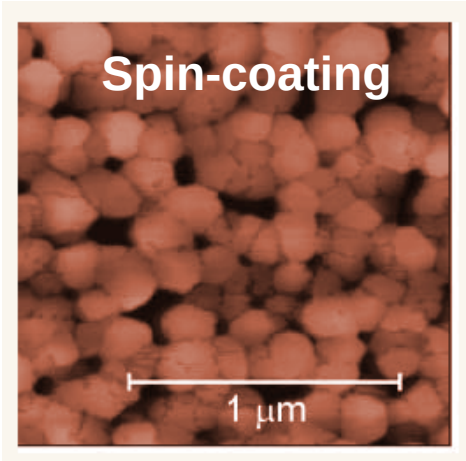
Mitzi et. al., *IBM J. Res. & Dev.* **45**, 1 (2001)

Synthesis

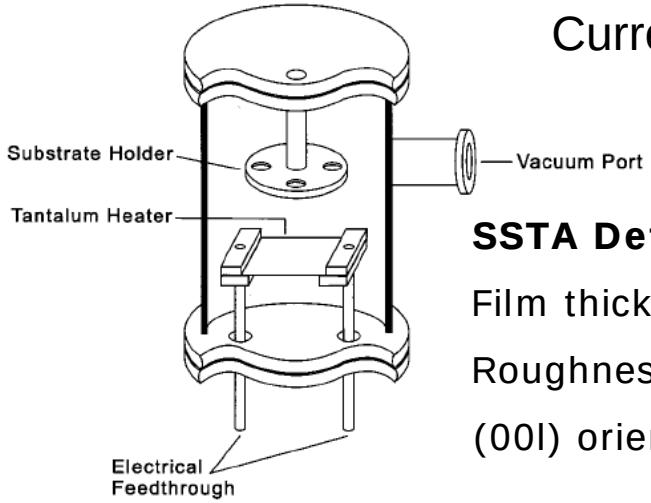
- Thin film deposition
  - saturation solutions
  - spin-coating
  - Single source thermal ablation (SSTA)
- Annealing
- Single source thermal ablation (SSTA)

OILED – side view





Mitzi et. al. (2001 and 2004)



Current EL <1% efficiency

SSTA Details: 1000 C in <5 sec

Film thickness 10 – 200 nm

Roughness <2 nm (RMS)

(00l) orientation, crystalline in stacking