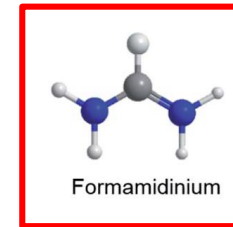
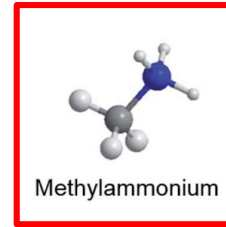
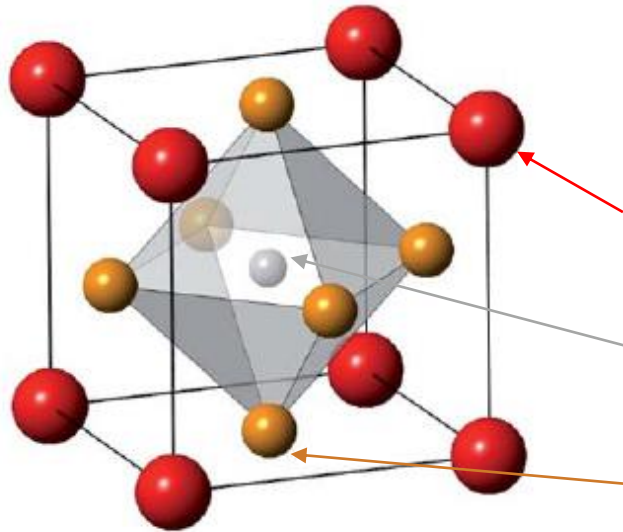
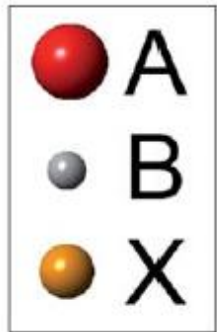




Perowskit Solarzellen: Hergestellt durch direkte Ko-Verdampfung

Prof. Dr. Steve Albrecht

Nachwuchsgruppenleiter Perowskit Tandemsolarzellen
Helmholtz-Zentrum Berlin, HySPRINT
Fakultät IV – Elektrotechnik und Informatik
Technische Universität Berlin



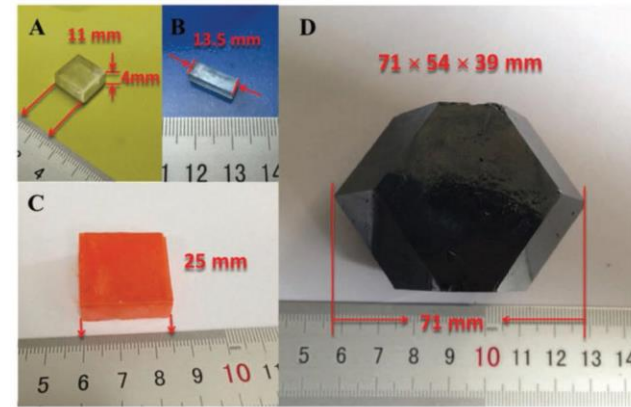
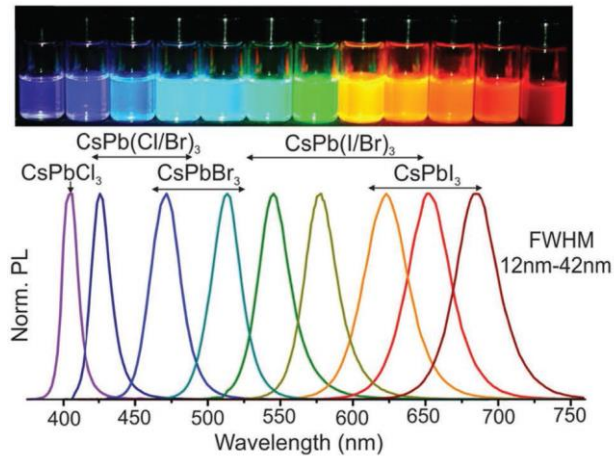
A = CH_3NH_3^+ or $\text{HC}(\text{NH})_2^+$ or Cs^+

B = Pb^{2+} (also Sb^{2+})

X = I^- or Br^-

Methylammonium lead iodide **$\text{CH}_3\text{NH}_3\text{PbI}_3$**

Snaith et al., Energy Environ. Sci., 2014, 7, 982

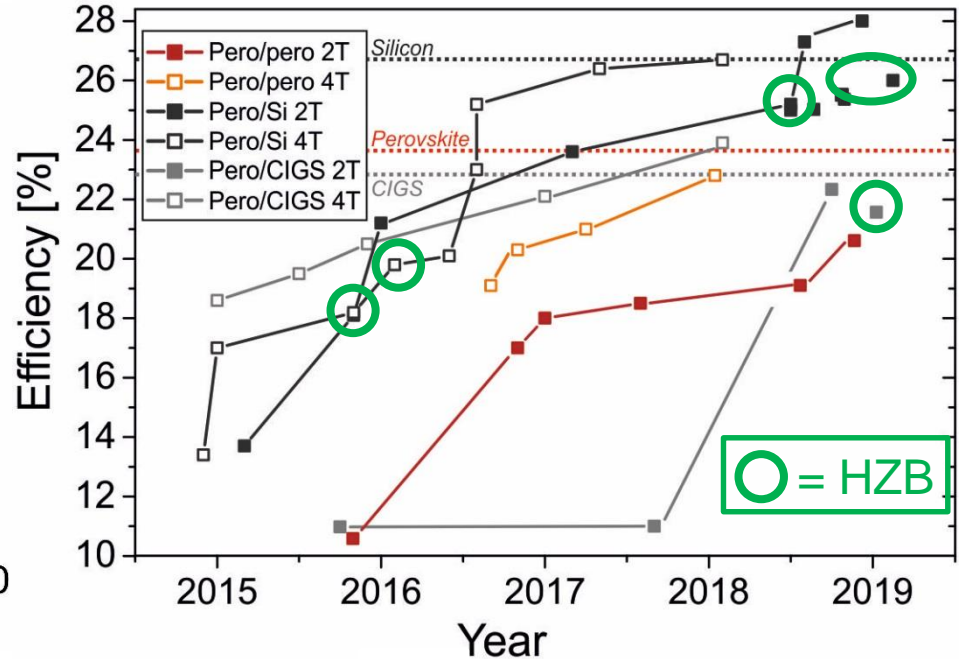
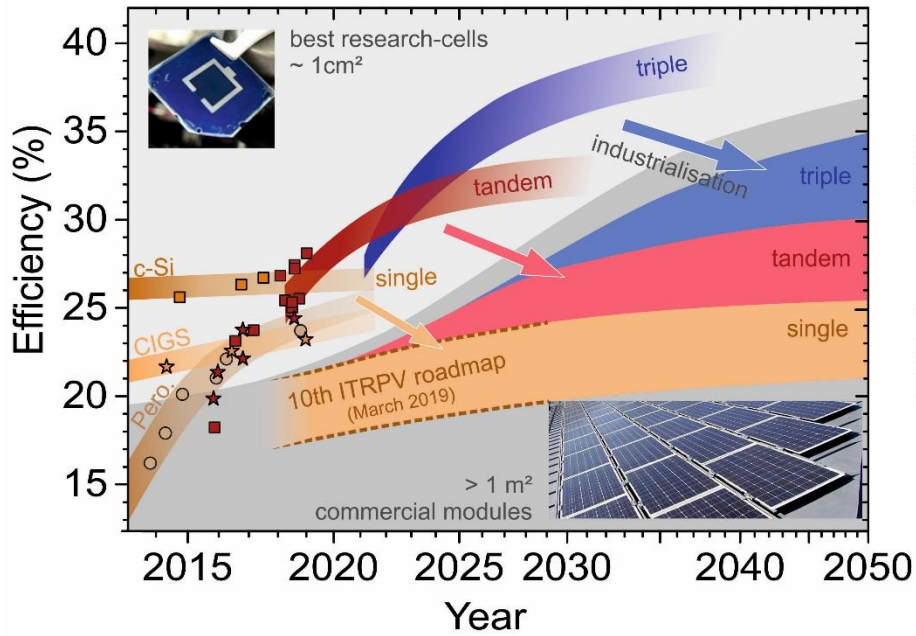


- Band-gap tuning
- Easy to process
- High optoelectronic properties
- Well suited for LEDs, detectors, solar cells



Stoumpos et al., *Adv. Ener. Mater.*, 2016, 28, 5778–5793

Updated from S. Albrecht and B. Rech,
Nature Energy 2 (2017) 16196.

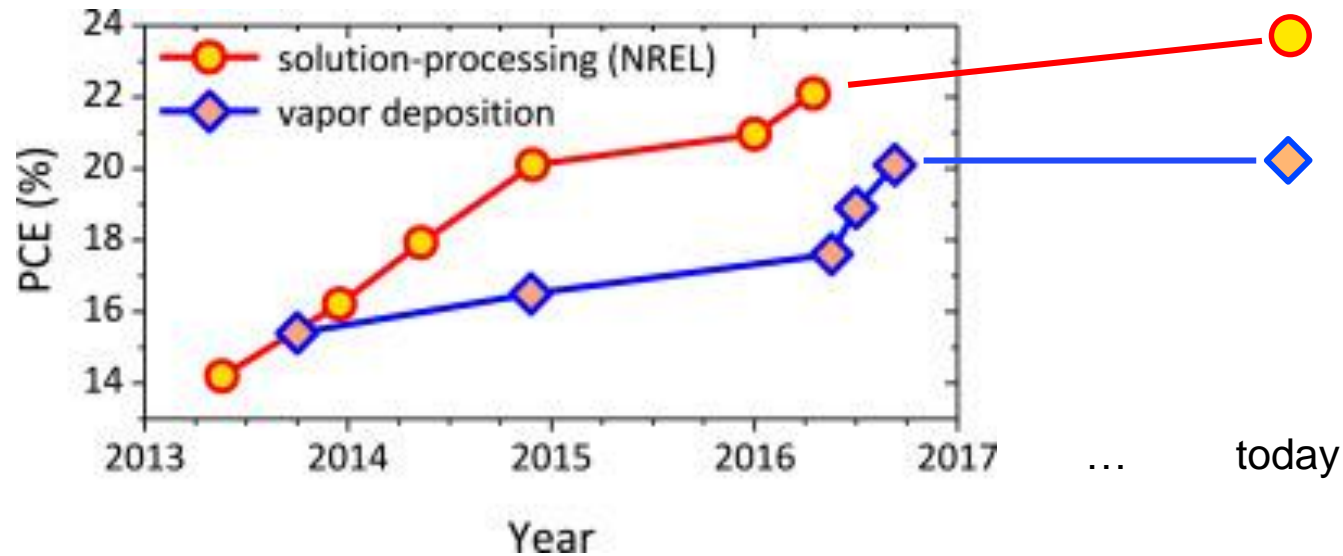


- Single junctions will be limited in efficiency
- Multi-junctions with perovskite top cells to overcome fundamental limitations

- HZB enabled 26% perovskite/silicon tandems
- HZB developed highly efficient Perovskite/CIGS tandems

Most tandem solar cells enabled with solution processing!

Perovskite solar cell efficiency



- >> 1000 papers on solution processing
- < 50 papers on co-evaporation
- With co-evaporation >20% efficiency was shown

Ávila et al., Joule 2017, 1, 431

Advantages

- Conformal coating on rough substrates
- No (toxic) solvents
- Good control over film thickness
- Scalable process
- Gradients, junctions etc.

Disadvantages

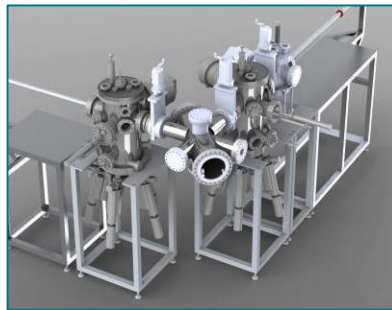
- Volatile components
- So far, limited in composition
- Record efficiency limited yet
- Complex process control

- Founded in 1999 as spin-off from Prof. Karl Leo's group at TU Dresden / IAPP
- Member of the **MBRAUN** Group

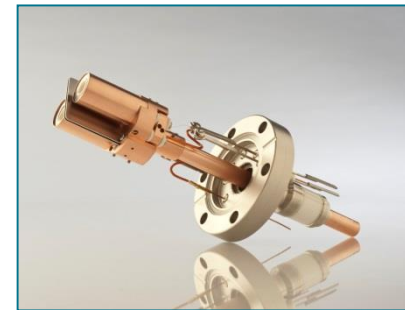
Activities:



Material Purification
Service & Systems



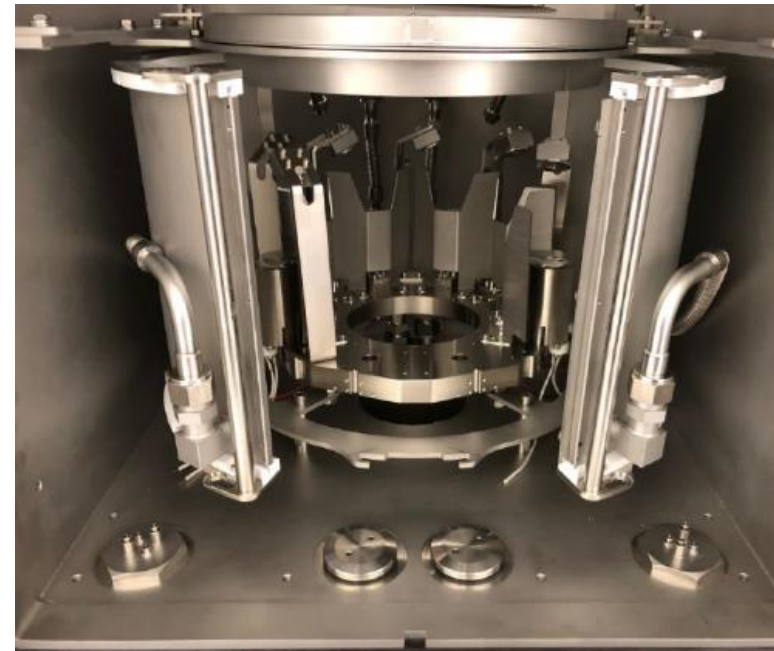
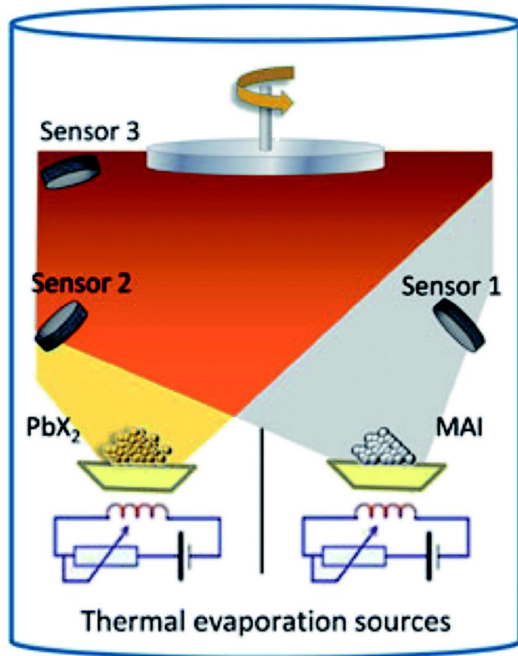
Thin Film Deposition
Systems



Evaporation Sources
& Components

Key figures:

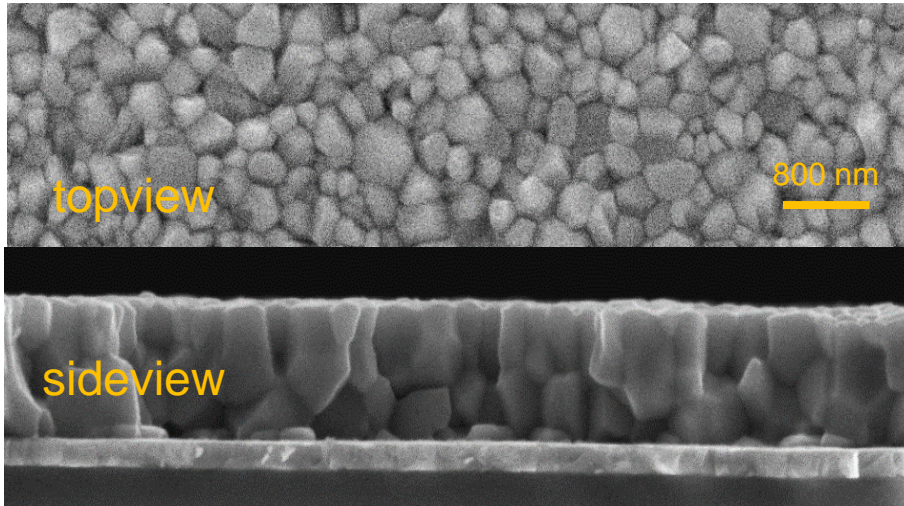
- Head count 22
- Filed IP rights > 10



- Thermal management system for volatile precursors
- Direct evaporation of MAI
- Improved control over co-evaporation process

Collaboration on perovskite
precursors

SEM



Solar cells

- First very promising results with efficiency $>20\%$

Value is among the highest reported for co-evaporated perovskite solar cells!

Marcel Roß, Amran Al-Ashouri

Thank you for your attention

