Zentrum für Sonnenenergie- und Wasserstoff-
Forschung Baden-Württemberg (ZSW)
Stuttgart, Germany

www.zsw-bw.de

// ZSW – Your Tandem Research Partner

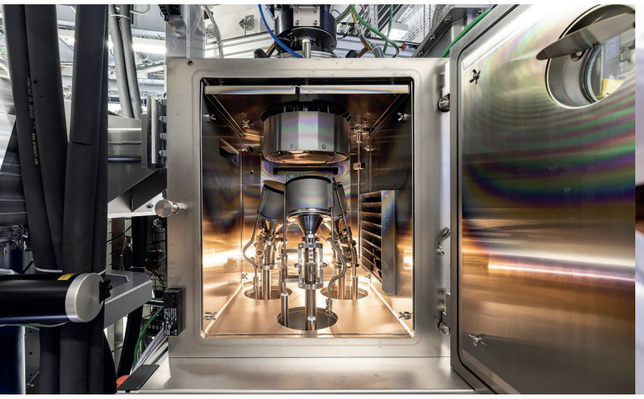
Photovoltaics is one of the main pillars of a climate-friendly energy system. In past decades, production costs have been cut and efficiency skyrocketed.

The present ambitious climate goals, however, call for an even faster and more massive expansion of PV installations. To this end, ever more efficient and ever more cost-effective solutions need to be developed and delivered to the market – fast.

Develop and deliver your PV solutions in tandem with us!

//ZSW – fast, excellent, reliable

Fast-track photovoltaics' advance with your favourite research partner



Who we are

- The centre of excellence for thin-film photovoltaics in Europe
- The catalyst for your innovative product ideas
- The committed research partner who speaks your language
- The successful partner in technology transfer

What we're good at

// Know-how

- Materials development
- Co-evaporation
- Sputtering
- Wet chemistry
- Analytics
- Quality control and long-term stability testing
- Technology transfer

// Company culture

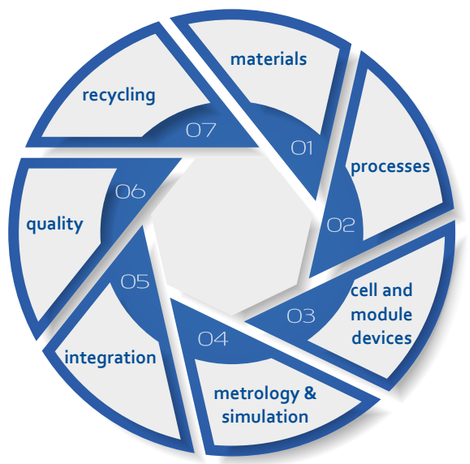
- Fast
- Excellent
- Reliable
- Down-to-earth

// Lab infrastructure

- Large area equipment (10x10 cm^2, 30x30 cm^2)
- Industrial-grade process technology
- Extensive, state-of-the art analytics equipment
- Solab: indoor and outdoor testing facilities

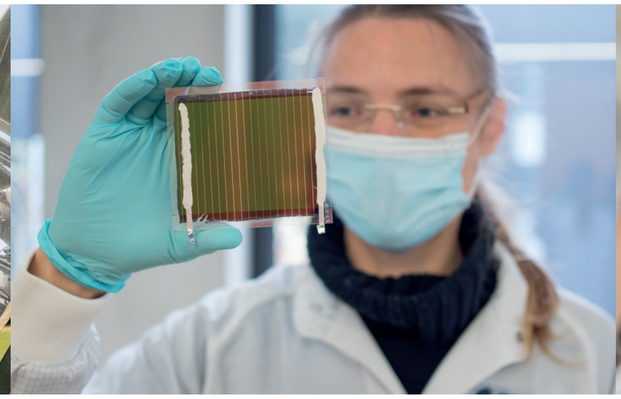
What we offer our partners

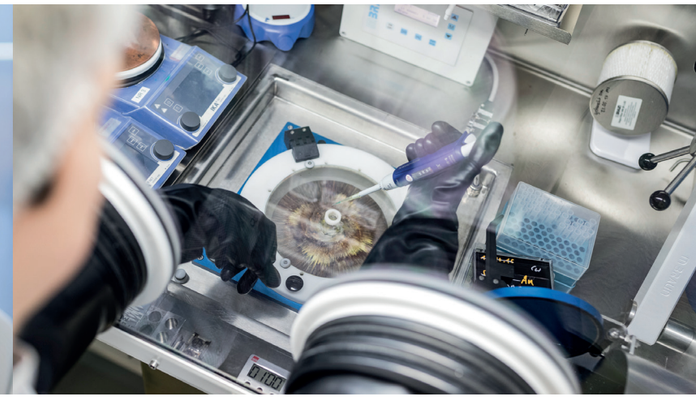
- > 30 years of experience in thin-film technology with several efficiency world records
- A proven track record in technology transfer
- A unique combination of excellent know-how and infrastructure
- Close cooperation in ramp-up and optimisation of your production
- An international network of research facilities to be drawn upon



//ZSW – Perovskite & Tandem Solar Cells

Invest in the next generation of photovoltaics





Perovskite is the up-and-coming material for high-efficiency photovoltaic modules. Especially its combination with, e.g., crystalline silicon, CIGS or other types of perovskite into a tandem solar module is the power booster for the conventional photovoltaics technology. Its potential efficiency ist far higher than that of single solar cells because of their better use of the solar spectrum. They can also be lighter and more flexible.

For the German and European PV industry, this emerging technology opens up new chances to increase their proportion of value-added. Production in Germany becomes more attractive for companies and the equipment manufacturers can be made fit to enter international markets with innovative PV products.

Perovskite Materials

Metal organic halides with ABX_3 structure.

- Highly efficient absorber compounds: Multiple-cation / mixed-halide systems
- Wide-gap material for use in tandem solar cells in combination with $Cu(In,Ga)Se_2$ (CIGS), Si or perovskite
- High efficiency > 20 % by defect passivation
- Lead-free and lead-reduced solar cells: Sn based absorber layers
- Development of sustainable production processes and stable solar cells

Perovskite Processes

- Vacuum-based evaporation
- Solution-based from small to large:
  - Spin-coating
  - Blade coating
  - Slot-die coating
- In inert or ambient atmosphere
- Rigid or flexible devices

Tandem solar cells and modules

- Perovskite/silicon, Perovskite/CIGS or perovskite/perovskite tandem devices can surpass the efficiency limitations of single-junction solar cells
- Efficiency potential > 30 %
- Ideal band gaps can be optimized for both sub cells
- Device simulation can be used to set up digital twins for production processes

If you would like to tandem with us, please contact:

Dr. Stefan Paetel
Phone: +49 711 7870-237
E-Mail: stefan.paetel@zsw-bw.de