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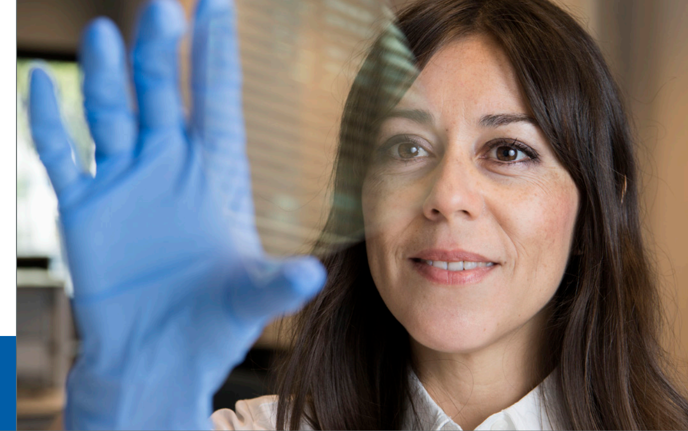

Excimer PLD Creates Superior Films for Improved Solar Cells

The Challenge

Solar cells, and other optoelectronic devices can all benefit from the development of functional thin film materials with device-compatible deposition methods. In several types of solar cells, one major challenge is the deposition of the transparent conducting electrode on top of sensitive layers of the device, for example the organic contact layers in halide perovskite solar cells. This problem is usually overcome by the use of inorganic buffer layers. A research team led by Monica Morales-Masis at the University of Twente has investigated whether pulsed laser deposition (PLD) would enable the fabrication of high-quality transparent electrodes for buffer-free semitransparent perovskite solar cells. (In addition to the low-damage deposition, wafer-based PLD is a requirement in solar cells applications.) Fortunately, a 248 nm KrF excimer laser from Coherent provided an ideal enabling solution for reproducible and scalable PLD.

The Solution

Utilizing a high pulse energy excimer laser at 248 nm to perform PLD on a 4-inch wafer, the group successfully demonstrated reproducible deposition of transparent conducting oxide (TCO) films on top of halide perovskite solar cells. Morales-Masis explains, “PLD is already well-established as a technique, e.g. for complex piezoelectric materials. We are now exploring the technique for solar cell materials, for which scalability and deposition rates that are at least on-par with sputtering deposition (commonly used in the field) are absolute requirements. The high stability of the COMPex laser – both the pulse-to-pulse energy stability and the beam homogeneity – is essential in delivering film uniformity and tight layer thickness control.”

To create the TCO films, the Morales-Masis team uses a PLD system from Twente Solid State Technology (TSST) where the excimer laser beam is swept back and forth over a solid target, ablating the material to be deposited onto substrates mounted on a circular platform which rotates continuously during the deposition. This ensures uniform film deposition over the holder containing four solar cell substrates.

The Result

High deposition pressure and room temperature PLD-produced Zr-doped In_2O_3 TCO films enabled the demonstration of semitransparent halide perovskite solar cells with 15.1% power conversion efficiency. This was demonstrated on buffer-free stacks, confirming the potential of PLD as a ‘low-damage’ deposition technique [1]. The group is now starting investigations of PLD of halide perovskites [2], to leverage an additional PLD advantage: stoichiometric transfer of multi-compound materials. The ability to create these halide perovskite films, with no solvents and over large areas in minutes is promising for future solar cell production.

“The high pulse-to-pulse stability of the Coherent excimer laser is a critical feature enabling uniform pulsed laser deposition over a large area.”

—Monica Morales-Masis,
University of Twente, Netherlands

[1] Y. Smirnov et al. DOI: https://doi.org/10.1002/admt.202000856
[2] V. Kiyek et al. DOI: https://doi.org/10.1002/admi.202000162