Morphology and topography of Perovskite solar cell films ablated and scribed with ultrashort laser pulses

Introduction
Perovskite thin-film solar cells attract an increasing scientific attention due to the excellent perspectives for commercial applications. In particular, both a high solar cell efficiency and low-cost production can be achieved due to the unique properties of perovskites.

For energy harvesting by modules the solar cell material has to be divided into small strips of individual solar cells that are interconnected in series by a specific sequence of deposition and patterning steps to reduce ohmic losses. Laser scribing is an industrial-validated technique for thin-film patterning that needs careful optimization to each photovoltaic material system to minimize dead areas, material defects, and additional ohmic losses. Hence, laser ablation and scribing of single as well as thin-film stacks were studied for such Perovskite solar module fabrication (CH₃NH₂PbI₃: MAPbI₃).

Results
Removing MAPbI₃ from films (P2)
Laser Ablation
SEM image of P2 scribes due to front side ablation, left: picosecond pulses, right: femtosecond pulses.

Low damage, well defined pattern by ablation

Removing films from MAPbI₃ (P3)
Characteristics to be considered:
- Low adhesion of gold films
- Melting and hydrodynamics of molten gold
- Tmₘg > TmMAPbI₃
- Decomposition of MAPbI₃

Low damage, well defined patterning with 355 nm ps-laser pulses

Discussion

- Perovskite thin films can be scribed successfully with ultrashort laser pulses by film and rear side laser irradiation applying different wavelengths.
- Laser thin-film delamination and lift-off processes are mostly observed.

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References