



Insights from the laser laboratory at Fraunhofer ISE: laser structuring (left) and optical setup for recording the ablation process at high temporal resolution (center) and flexible beam shaping using phase modulation (right).

The Fraunhofer Institute for Solar Energy Systems ISE is the largest solar research institute in Europe. With our current staff of about 1200, we conduct application-oriented research for the technical use of solar energy and develop materials, systems and processes for a sustainable energy supply.

Laser processes are used in many ways in the production of crystalline solar cells, whether for processing the silicon semiconductor, dielectric layers or various structuring processes. In the laser laboratory at ISE, we develop current industrial processes and laser systems further, build systems for deeper process understanding and design new machine concepts.

Research Trainingship and Master Thesis: Spatially and temporally flexible laser heating of semiconductors to reduce crystal damage

Thermal processes play a crucial role in the manufacture of semiconductor devices. Whether in epitaxy, for diffusion, in contact firing or in the treatment of material defects - heating processes are used in many ways in the manufacture of solar cells. In this context, lasers are increasingly being used as a heat source. Lasers are very flexible tools that can be modulated in time and space and bring workpieces to high temperatures without themselves becoming hot. However, the large variety of parameter combinations and possibilities is far from being fully explored.

This call specifically addresses the following question: "To what extent can pre-conditioning as well as post-conditioning of the workpiece using laser heating increase the process quality in production steps that generate crystal damage?" The work items are:

- Construction of an optical system to perform beam shaping. For this purpose, the concept of the setup and the phase modulator as the core element are already in the laboratory. In order to be able to use the phase modulator, knowledge in wave interference and Fourier transformation between spatial and frequency space must be acquired or deepened.
- Laser heating of silicon wafers with different beam shapes at different dwell times per spot.
- Recording of the temperature distributions on the wafer during and after laser heating.
- Determination of the correlations between the temperature distribution and distribution of the laser intensity on the sample.
- Integration of the setup into the laser processing station and use of the modulated laser during a structuring process.
- Comparison of crystal damage after structuring with and without accompanying laser heating.

This work will take place embedded in a project and in active collaboration with a young dynamic team of experienced collaborators. It is designed to last one year (6 months trainingship + 6 months master thesis).

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