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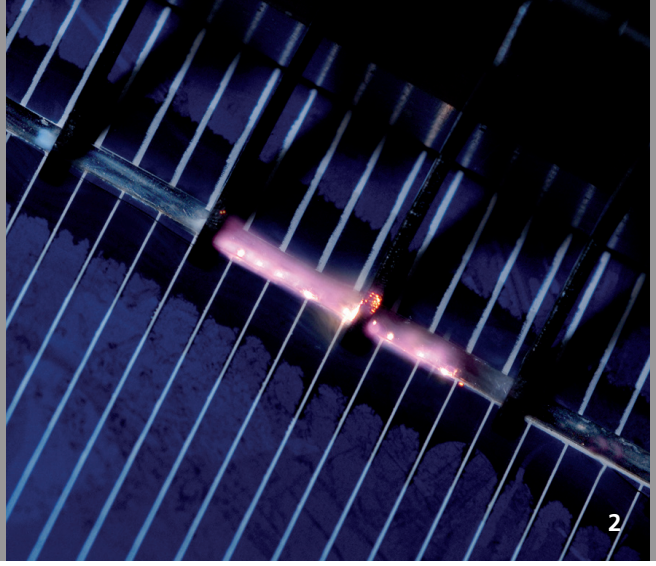

2



# CONTROLLED LASER-BEAM SOLDERING OF SOLAR CELLS

## Task

To advance future cell and module designs in photovoltaics, new sensors and control technology are needed to improve the quality of the laser-beam soldering process. The process development presented here pursued different approaches to laser soldering, such as locally fixed energy input by line optics and locally variable energy input with scanner optics. This project's reported goal is to meet the requirement for thinner cells as well as lower energy input; in addition it aims to increase production quality and, thus, improve the ecological balance in the production of solar modules.

## Method

Using pyrometric signal acquisition during the different soldering processes with varying process parameters, Fraunhofer ILT identified a characteristic curve of the temperature profile even with very different processing parameters, e.g. the irradiation time. The pyrometric signal was calibrated with high-speed imaging of the upper cell connector so as to characterize the temperature profile in the visible process phases during the soldering process. The visual analyses were compared with the pyrometric signal, which in turn make it possible to determine the individual process stages and a characteristic feature, the latter of which can be used for process control.

*1 Pyrometric Controller (Source: Amtron GmbH).*

*2 Laser soldering process.*

## Result

As an example, in the control system, a high-speed pyrometer was integrated in the beam path for the scanner-based soldering. Thanks to a novel control strategy, an absolute temperature measurement is not required and aberrations of the optical system can be compensated. The cell connectors to be brazed to the solar cell have been divided into several sections. For each of these sections, the laser power can be controlled during the soldering process depending on the temperature profile measured.

## Applications

By tapping into the quality optimized laser soldering through innovative application engineering (among others, multisystem pyrometry, multi spot optics), Fraunhofer ILT has been able to combine simultaneous energy input, adapted laser beam geometry and multiplication means thanks to multispot optics. This expands the application spectrum of the laser soldering far beyond photovoltaics to other electronics products.

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