Solar cell production with TRUMPF:

Getting more out of the sun.
Double the knowledge for better solar cells.

The highest levels of efficiency and production in cycles only seconds long: TRUMPF’s innovative products can help you find new approaches to solar cell production. We are opening up new opportunities for solar cell manufacturers and facility builders. In addition, you will receive the support you need for your project through the combined experience and comprehensive, worldwide service from two leading technologically innovative TRUMPF Group companies.

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TRUMPF: Technology and world market leader in lasers and laser systems.

TRUMPF promotes the development of industrial lasers. For the efficient manufacturing of solar cells, TRUMPF has lasers with short pulses at a high average output. An example of this is the picosecond laser that is used to structure thin layers of Molybdenum and achieve excellent quality at a high productivity level.

Whether it’s a job requiring patterning, edge deletion, edge insulating, removal, structuring, cutting, drilling or marking: at TRUMPF you will find lasers of all wavelengths and in many configurations. In short, you will always find the right laser whatever your application. The standardized, reliable laser solutions from TRUMPF have been in use for many years in many industries.

HÜTTINGER Elektronik: The innovator for generators.

Being a member of the TRUMPF Group since 1990, HÜTTINGER Elektronik supplies plasma process power supplies for a large range of plasma-assisted film deposition processes. Our long experience and extensive know-how in plasma technology provide you with the base to develop reliable and stable processes for solar cell production. DC, MF and RF power supplies offer all required features for precise control of film growth from various source materials.

Moreover, HÜTTINGER is the European leader in manufacturing power supplies for zone float processes in the production of solar-grade silicon stock material.
HÜTTINGER generators and TRUMPF lasers offer ideal features for efficient manufacturing of affordable thin film solar modules. Transparent conductive oxide (TCO) coatings as well as photo-active layers in a-Si/μc-Si solar cell structures are deposited in solar front-end production. Subsequent to each coating process, laser scribes are used for patterning the surface into suitable cell segments and required inter-connections. Our expertise in coating and structuring thin-film solar modules facilitates your path to innovative solutions. In production back-end, lasers are used for edge stripping, effectively giving the finishing touch to the thin-film solar module.
Patterning: Precision and speed.

Structuring with the laser, also called patterning, divides thin film modules and wires up the generated cells. In the sunlight, the charge carriers in the cells are separated and the current flows through the contacts generated using structuring to the edge of the solar module. The precise, selective and contact-free laser processing is process-dependable with short processing times. Nanosecond lasers can also be used for the production of modules with amorphous silicon and cadmium telluride.

Entirely new areas of application are opened by innovative picosecond lasers from TRUMPF. There is no molten material due to its short pulses. You can use it to remove the molybdenum in CI(G)S modules at a higher speed and without cracks. “Cold” processing of the photo-active layer with ultra-short laser pulses also offers high quality and productivity advantages over mechanical processes.

Full control in plasma-assisted film deposition processes.

Cell efficiency is the key feature for the characterisation of solar cells. Homogeneous TCO front contacts and highly conductive metal back contacts significantly influence cell efficiency. With HÜTTINGER process power supplies, highest levels of plasma control are possible, resulting in top results for homogeneity and reproducibility of deposited film thickness and structure.

Typical for film deposition processes are RF power supplies that enable PECVD for photo-active a-Si/µc-Si layers and DC power supplies which create plasma in magnetron sputtering processes for TCO layers.
Removal and edge deletion: Superior features.

For stripping the coatings, TRUMPF lasers are the affordable solution for a high flow rate. Large-area removal is performed on the edge of the module by dividing up the large areas to ensure constant lamination. For this purpose, the use of lasers is cleaner than sandblasting and easier to integrate into the line. With TRUMPF lasers, you can rely on high performance for short cycle times. In addition, if you distribute the energy to numerous workstations with laser light cables, the laser power from one station can be used at another during loading and unloading cycles, increasing overall productivity.

Schematic design of a production line of thin layer modules with TRUMPF and HÜTTINGER components.
The TRUMPF Group opens up new horizons for production of crystalline solar cells. Already in the production of solar-grade silicon stock material, HÜTTINGER power supplies are key to provide homogeneous silicon melt through induction heating. In the processing of solar wafer cells, the blue anti-reflection coating is deposited in a PECVD process, where thickness and homogeneity are precisely controlled via the HÜTTINGER process power supplies for the RF plasma. For cell reverse side contacting lasers are utilised to create 3D structures in the cell surface. Lasers work contact-free and are most flexible in positioning and sweep control. And, no mechanical stress poses any risk for wafer breakage.
Solar-grade silicon stock material:
Process power to satisfy the world’s demand for solar.

With the strong growth of solar power installations worldwide, the demand for solar grade silicon has risen dramatically. HÜTTINGER induction process power supplies are key to provide the energy for melting and heating silicon in zone-floating and crystal-pulling applications. At high power and high efficiency, solar-grade silicon wafers can be produced at new cost levels. This is HÜTTINGER’s contribution to reach grid parity even a little earlier.

Cutting or drilling:
New concepts to better use the surface area.

When cutting out wafers, a TRUMPF laser separates the silicon with equal precision and speed. In addition, the shadowing on the front side of a solar cell can be reduced by applying contacts on the reverse side and drilling inlet holes with the laser. A TRUMPF laser does this in the production cycle. And the drill holes cover less than 1 percent of the surface area.

Coatings:
For more or less reflection.

An optimized crystalline cell with an anti-reflex and reverse contact layer can achieve a considerably better level of efficiency. HÜTTINGER generators produce the plasma for applying these layers through a magnetron sputter or PECVD process. Thanks to its ideal features, such as arc management, the cells receive particularly high quality coatings.
Reverse side contacting: Efficiency increases.

To increase reflectivity on the reverse side and to avoid electrical losses, a transparent insulating layer and a metallic coating are applied across a large area. The laser allows you to achieve targeted contacting on the reverse side of the solar cell with the lowest output losses on the contact points. There are two ways to do this: Either you use the laser to shoot the contacts through the layer system onto the wafer, known as laser fired contacts, or you use the laser to remove the insulating layers before the metal coating is applied. With selective removal of the insulating layer, ultra-short pulses operate without added heat creating disruptions in the silicon.

Edge insulation: No short-circuit – thanks to the laser.

Due to the circumferential doping, short-circuits automatically develop on the front and reverse side of a crystalline solar cell during production. When the laser is used to insulate edges, it generates a separating line at lightning speed that reliably eliminates the short-circuit.

Solar module assembly: Inter-cell contacting via induction or laser soldering

When multiple solar cells are arranged into solar modules, all cells in the module need to be connected in a series of strings. The metallic contact band is soldered to the cells via a precisely positioned heat transfer. There are two methods to realise this heat transfer for the solder process: Induction heating via specialised inductor or laser soldering. Both, the induction heater and the laser can easily be integrated in the assembly tools. For the best adaptation to your soldering process, HÜTTINGER provides comprehensive application support to design the specialised inductor.

Also, you can count on TRUMPF if you are looking for a laser for marking solar cells. You will no doubt find a suitable solution in our broad product portfolio.
More service worldwide.

TRUMPF offers you comprehensive support around the world. Our service begins long before you even decide on a solution. We provide comprehensive consulting services to help you define the process and figure out which solution you really need.

Thousands of application tests performed annually in the application center.

Feasibility studies in one of our application centers are a central component of our basic consulting services prior to purchase. Either you will learn exactly which TRUMPF laser, beam guidance and parameters you need for your application or you will see which HÜTTINGER generator and which inductor design will provide the optimal features for your process.
All around support – even after purchase.

We will support you worldwide with customized services through the entire service life of your system. Our experienced application technicians will help you install and start up your processes. We will assist you with maintenance and train your employees. We keep downtime and technician visits to a minimum because by using remote diagnostics or Telepresence, our specialists can, with your permission, access your system online and solve problems. And should you need a spare part, we are available 24/7, 365 days a year worldwide.
Products:

Find everything you need in our vast portfolio.
TRUMPF lasers and HÜTTINGER generators offer a broad range of products for use in the production of solar cells.

**TRUMPF: The right laser for every application.**

You can be sure that you will always get the best laser for your individual application from TRUMPF’s extensive product portfolio.

Our nanosecond lasers of the TruMicro Series 3000 enable selective and precise material ablation with high feed rates. Lasers from the TruMicro Series 5000 are powerful pico-second lasers. They are used for extremely sophisticated surface treatment, such as highly productive and precise removal without heat-affected zone. They are available in three wavelengths: 1030 nm, 515 nm and 343 nm. And with the TruMicro Series 7000, you can quickly cut, drill, ablate or remove large-area layers, thanks to the laser outputs of up to 750 watts and pulse energies of up to 80 mJ.

Lasers from the TruMark Series 6000 also cover all three essential wavelengths: from infrared with 1064 nm to 532 nm up to UV lasers with 355 nm. Lasers from this series are used for wafer marking and patterning. They are not only extremely easy to integrate into the production lines, they can also be operated on any power grid on Earth. This also applies to the TruMark Series 3000 that is even more compact.

Whether used for welding modules, cutting the most sophisticated contours or drilling small holes, the lasers from the TruDisk, TruFiber and TruPulse Series have the best features for applications in module production and processing.
HÜTTLINGER: The suitable process power supply for your application.

Generators from HÜTTLINGER - proven a thousand times over - are the best starting point for stable processes in the production of solar cells. We offer a large selection of DC, medium frequency (MF) and high frequency power supplies for induction heating and plasma excitation. This means that you are able to select the exact fit of generator for the requirements of your process, whether for thin-film or crystalline silicon solar cells. Whatever your requirements, you can rely on our innovative ultra-fast and reliable arc management. Even the largest substrates can be coated without arc damage, thanks to the extensive experience of generators from the world market leader for flat panel display and architectural glass coatings.

HÜTTLINGER DC generators of the TruPlasma DC Series 3000 are an affordable investment into processing TCO layer in magnetron sputtering tools. The excellent arc management CompensateLine ensures particularly smooth and clean process results. Generators of the TruPlasma MF Series 7000 provide stable and reproducible results for intermediate layers in solar cells, like i-ZnO.
And as the most recent addition to the HÜTTINGER portfolio of power supplies, the TruPlasma RF 1003 generator provides 3 kW of RF power at 13.56 MHz for PECVD processes. More than 80 % of energy conversion efficiency and an exceptional level of robustness provide new potentials for production cost reductions and continuous production at highest throughput in your solar cell manufacturing line.
TRUMPF is certified according to ISO 9001:2008
(for further information see www.trumpf.com/en/quality)