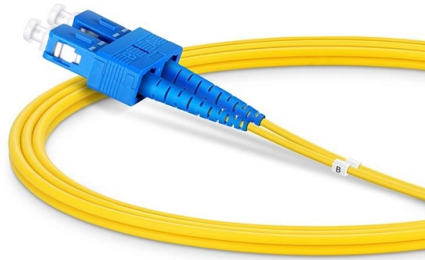


Southern European PV Diode Laser Processing Methods



Overview

Laser Technology in Photovoltaics Fraunhofer ILT develops industrial laser processes and the requisite mechanical components for a cost LASER TECHNOLOGY IN.

Key Takeaways

Diode laser processing in photovoltaics enables high-precision ablation, selective emitter formation, and interconnection of solar cells, improving efficiency and reducing production costs. Overview of PV Laser Processing

In Southern Europe, as in other industrial regions, laser technology is central to modern PV manufacturing, particularly for both crystalline silicon and thin-film solar cells. Diode lasers are favored for their high efficiency, compactness, and precise wavelength control, which allows selective processing of thin conductive, anti-reflective, and passivation layers without damaging underlying materials .

Key Diode Laser Methods

- Selective Ablation and Scribing
- Diode lasers are used to remove nanometer-thin layers at defined points, such as transparent conductive oxides (e.g., ITO) or passivation layers, enabling monolithic series interconnection in thin-film PV modules .
- Depth-selective ablation allows roll-to-roll production on flexible substrates like steel foil, reducing material waste and improving throughput .



- Laser-Doped Selective Emitter (LDSE)
- Diode lasers locally modify the doping profile of silicon solar cells to create highly conductive regions for improved current collection.
- This method minimizes voltage and fill factor losses while enhancing overall cell efficiency .
- Rear Contact and Metallization Processing
- High-precision diode lasers can fire aluminum foils into silicon to form SiAl alloys for rear contacts, offering a cost-effective alternative to plating or printing techniques .
- Laser drilling and patterning enable interconnection of shingle cells and back-contacted designs, supporting high-efficiency module architectures .
- Hybrid and Thermochemical Approaches
- In some cases, thermochemical ablation is combined with diode laser irradiation to reduce defects such as bulges or delamination in thin layers .
- Optimized pulse duration, wavelength, and spatial shaping are critical to maintain layer integrity and high throughput.

Advantages in Southern European PV Manufacturing

- High Precision: Diode lasers allow micron-scale accuracy, essential for IBC (interdigitated back contact) cells and advanced thin-film designs .
- Cost Reduction: Laser processing reduces material consumption and enables faster production speeds (up to 10 m/s for ultrashort pulsed lasers) while maintaining quality .
- Flexibility: Applicable to both crystalline and thin-film PV technologies, supporting diverse European manufacturing lines.
- Integration: Diode laser systems can be inline or stand-alone, facilitating retrofitting of existing production lines .

Emerging Applications

- High-Power Laser Beaming: Research explores direct illumination of PV diodes with high-power infrared lasers for remote energy generation, which could complement conventional PV systems in Southern Europe .
- Hybrid PV + Thermoelectric Systems: Combining diode laser-processed PV cells with thermoelectric generators can enhance energy harvesting efficiency in high-temperature environments .

Conclusion

Southern European PV manufacturers increasingly rely on diode laser processing for selective ablation, emitter doping, and metallization, enabling high-efficiency, low-cost solar cells. Optimized laser parameters, hybrid processing strategies, and integration into automated production lines are key to achieving industrial-scale performance and reliability .

Article Content

Diode Laser for Photovoltaic Manufacturing: Solar Cell Guide

Learn how to select the right diode laser for photovoltaic manufacturing. Match wavelength, power stability, and beam quality to your

(PDF) Laser applications in thin-film photovoltaics

Unlike traditional panels based on crystalline silicon wafers, the individual cells of a thin-film photovoltaic module can

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