Plasma-enhanced LTPS-annealing

This present procedure offers a boost in efficiency and productivity of laser-based amorphous semi-conductor anneling processes. This increase in efficiency is realized by interaction of a homologously shaped laser beam with a standard pressure plasma, e.g. a plasma layer, in direct proximity to the material surface.

Challenge

For an efficient and cost-effective production of displays with screen diagonals larger than 42 inch using the Low Temperature Poly Silicon (LTPS) method, it is necessary to realize the a-Si cristallization process as homogenous and on an as large as possible area, with as low energy intake of the carrier material as possible. The goal of this invetion was therefore, to maximize the conversion of laser energy into thermal energy within the semiconductor layer, to enable a large-scale processing without costly optics and high-power lasers.

Our Solution

It was shown that a standard pressure plasma interacting with both the laser and the semiconductors surface during a laser-based LTPS annealing process was able to significantly boost efficiency of laser-to-thermal-energy conversion within the exposed substrate. It is at the same time beneficial, when the thickness of the plasma layer is kept below 5 mm and the electron density significantly below the cut-off for the corresponding laser wave length, to keep energy losses due to interactions between the laser beam and the plasma below 1 %.

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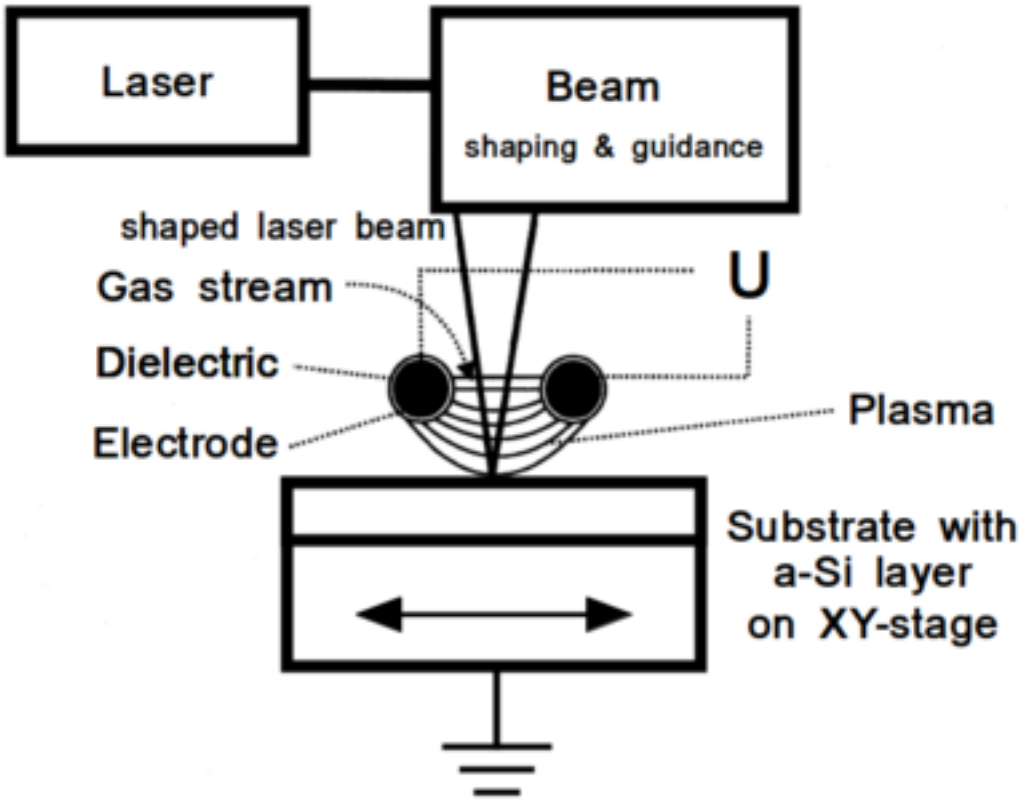

LTPS-setup with remote plasma. U: high voltage source with alternating current.

Advantages

- Increased efficiency and cost reduction for production of large LTPS-displays
- Reducing of laser intensities while increasing homogenous cristallstructure distribution
- Retrofittable with existing systems
- Working under standard pressure (no need for low-pressure setups)

Applications

Production of large-scale technical components based on polycristalline silicon, such as Thin-Film Transistors (TFT).

Development Status

Functionality verified.

Patent Status

German patent: DE102009050680B4
Korean patent: KR101736520B1

Patent holder:
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References

Increase in Generation of Poly-Crystalline Silicon by Atmospheric Pressure Plasma-Assisted Excimer Laser Annealing, Gredner et al., Journal of Materials Science and Engineering (2013).

Plasma-Enhanced Laser Materials Processing, Gerhard, Viöl, Wieneke, (2016), DOI: 10.5772/61567

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