SiTaSol-

Industrial scalable low cost front side processes for III-V/Si solar cells

Nastaran Hayatiroodbari, Carina Hendler, Alexander Wheeldon, Roman Trattnig

CONTACT

JOANNEUM RESEARCH
Forschungsgesellschaft mbH

MATERIALS
Institute for Surface Science and Photonics

DI Dr. Roman Trattnig

Franz-Pichler-Strasse 30
8160 Weiz

Phone +43 316 876 3000
Fax +43 316 8769 3000

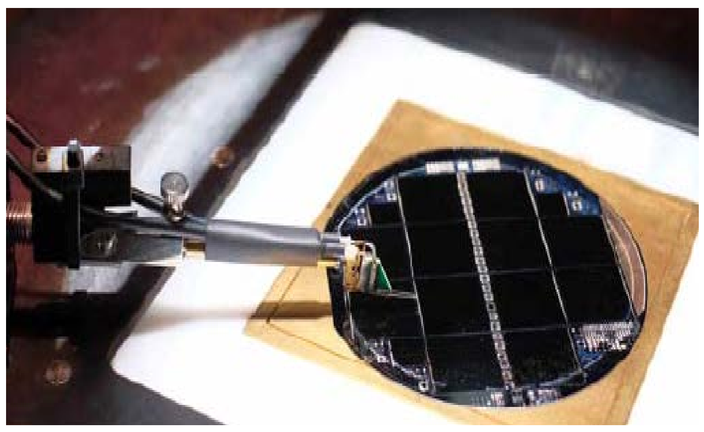
roman.trattnig@joanneum.at
www.joanneum.at/materials

The Task

III-V compound-based solar cells present the highest efficiency among the other commercial solar cells. The main challenge to make these devices good competitors on the market is to reduce their high manufacturing costs. In order to address this challenge SiTaSol by focusing its R&D activities on low cost processes for a two-junction, two-terminal III-V/Si tandem solar cell. The cell has a realistic 32% efficiency potential (at AM1.5g).

As an example, low cost back-end processes such as spin coating and inkjet printing methods for the deposition of front side electrodes are promising replacements for expensive standard front contact processes like photolithography and metal evaporation.

In the project Joanneum Research investigates these methods in order to make them applicable as low cost large scale BEOL processes that are suitable for replacing current expensive standard processes.



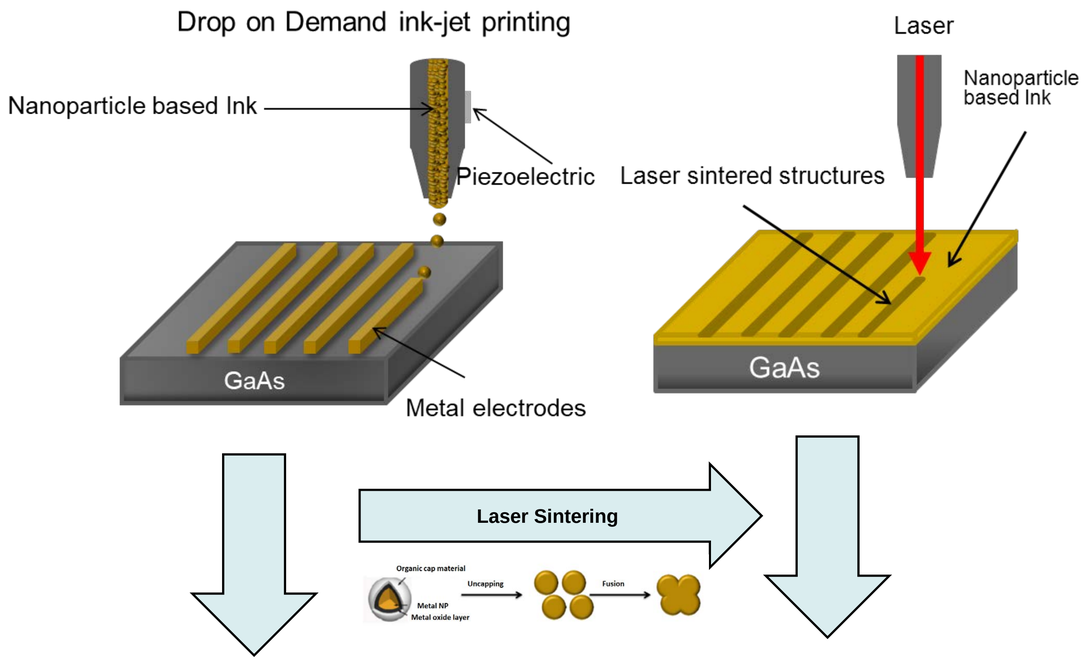
Task Goals

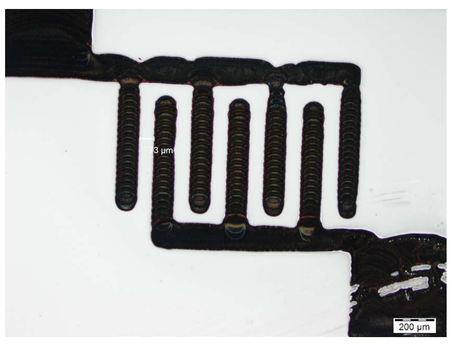
Main task of the activities is the development of industrially scalable low cost processes for the front contact grid and anti-reflection coating for III-V/Si tandem solar cells. In particular, the following specifications are targeted:

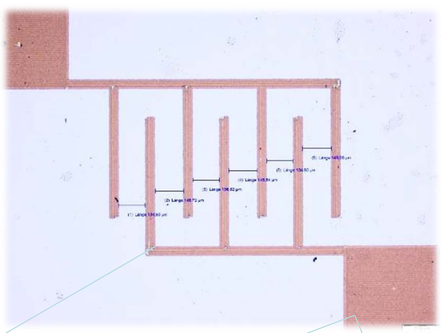
- Total series resistance of electrodes < 1 Ohm cm²
- Less than 2% of the front side area is shaded by electrodes and the reflection losses are < 4% (spectral average).
- Developed processes are industrially scalable and comprise no photolithography. Only non-critical materials in particular with respect to environmental impact are used.

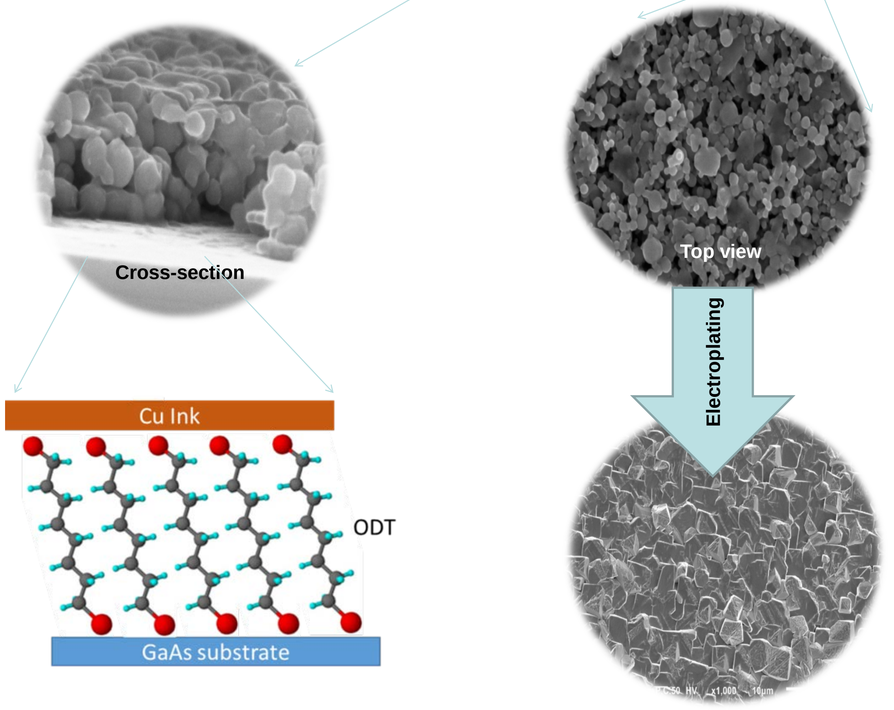
Results

- Inkjet-printing was applied as a flexible manufacturing method to print metallic nanoparticle ink for low-cost front side electrodes with a structure size in the micron range (< 50µm) on III-V wafers.
- The size of metallic nanoparticles in the range of nanometers provides the ink with the ability to be inkjet-printed and also decreases the nanoparticle melting point to a lower temperature compared to their bulk forms, thereby reducing manufacturing costs.
- Sintering of inkjet-printed contact structures by ultra-short pulsed Laser beam was applied as efficient electrode formation process.
- A cost efficient standard electroplating process finally is applied for growth of front contact electrodes from printed seeding structures.
- Electrical contact characteristics between electrode and III-V semiconductor was evaluated by Transmission Line Method (TLM) and could be determined to be <10 mΩ cm². In addition, a shading of the active front side area of less than 2% was achieved by minimizing the lateral dimensions of electrodes.
- Finally, in order to reduce a potential diffusion of metalic atoms from the electrode to the semiconductor, an organic self assembled monolayer (SAM) was applied as diffusion barrier.









Conclusion

In conclusion, three well-known BEOL methods, spin coating, inkjet printing and Laser sintering were successfully combined for the deposition of conductive metallic nanoparticle ink as front contact electrodes for III-V /Si solar cells.
As a result a low contact resistivity of <10 mΩ cm2 was achieved. In addition, by minimizing the lateral dimensions of electrodes less than 2% of the front side surface are shaded.

Acknowledgement

The research leading to these results has received funding by the European Union's Horizon 2020 research and innovation programme under grant agreement n° 727497.