

# High performance crystalline silicon photovoltaics

The growth of the PV sector relies on sustained cost and technology improvements. The CSEM PV-center develops and integrates innovative process technologies and devices concepts for high performance crystalline silicon photovoltaic devices.

Mature wafer-based crystalline Silicon (c-Si) photovoltaic (PV) technologies dominate the solar electricity sector with over 90 % of the total PV market share. The majority of c-Si modules reach efficiencies of 15% to 18%, with decreasing production costs. A highly competitive market situation in the PV sector sets an intense pressure to improve every aspect of the technologies, including conversion efficiency, material costs, equipment costs and throughput, system installation costs and energy yield. The CSEM PV-center has therefore put a strong emphasis on developing innovative process technologies and device concepts which can be produced with competitive industrial processes to improve c-Si PV devices performance and define tomorrow's mainstream technologies.



Typical screen-printed c-Si solar cell

The CSEM PV-center carries out applied research over the entire process chain from wafer preparation to c-Si cell processing and metallization in its high-end clean room facilities, aiming at developing innovative ultra-high efficiency cell and module concepts while ensuring reduced manufacturing process cost.

The PV-center infrastructure includes high-end wet-bench for wafer texturing and cleaning, a complete park of advanced and state-of-the-art low and high temperatures PECVD, PVD and ALD tools, fine-line screen printing, firing, electro-plating, and laminator for modules encapsulation. The technological park of equipment is completed with high end characterization tools, allowing for complete material characterization to cell and module measurements and diagnosis set-ups.

The CSEM PV-center develops, and offer R&D services related to:

#### Advanced low-temperature processing technologies

- Silicon heterojunction solar cells and derivatives, targeting commercial cell efficiencies > 23%. Heterojunctions are a disruptive product having the decisive advantages of i) combining a high efficiency potential with a simple architecture and limited production sequence steps and ii) exhibiting a low temperature coefficient (- 0.3 %/C and below), leading to lower temperature losses and higher energy yields.

#### High efficiency crystalline silicon solar cells

- Passivated emitter and rear solar cells (PERC), with commercial cell efficiencies > 20%. PERC cells are an evolution of the mainstream homojunction product, which serves most of the current market.

#### New cell architectures, innovative passivation and contacting concepts

- Pre-competitive research on device architectures and industrial processes for ultra-high efficiency c-Si PV devices, targeting > 25 % conversion efficiency and transfer of these technologies.

#### Advanced metallization technologies and materials

- Processes, technologies and materials for contacting and interconnecting solar cells, targeting reduced costs and increased performance via reduced shadowing losses and decreased series resistance.

#### Design and prototyping of application specific c-Si PV devices

- Design, development and prototyping of customized pattern cells, concentrator cells, high energy density cells, low illumination cells for consumer electronics, or other specialty products, based on specs and/or optimized for specific applications.

The CSEM PV-center offers the possibility to access its high end infrastructure for development activities as well as for service contracting. It further proposes its competences and expertise in characterization of materials, coatings, cells and modules, as well as its leading know-how in c-Si and general PV technologies.