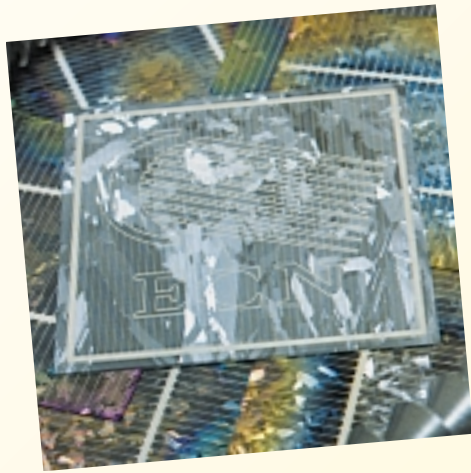


R&D of Solar Cells and Modules

Achievements

- Realisation of a flexible pilot line for the processing of crystalline silicon solar cells and modules with a capacity of 500 wafers per day.
- Development of a new cell and module concept, called the Pin Up Module, for improved efficiency and easy module manufacture.
- Invention of a simple characterisation method for contact resistance mapping.
- Invention of a mathematical method for optimising metallisation patterns in two dimensions.
- Implementation of an industrial type of processing for mass production, development of production machines and optimisation of production lines for cell and module efficiency.
- Development of stencil-printing technology leading to lower operating costs and higher efficiencies than screen-printing.
- Making the first back contacted solar cell module using industrial type processing, focussing on the use of screen-printing technology and simple etch procedures.
- Development of the first screen-printed dye-sensitised 'organic' solar cells on flexible plastic substrates.
- Design of an organic solar cell based on simple and easy processing to enable large-scale production of cells for indoor and outdoor applications.
- Realisation of the growth of closed silicon layers on silicon based substrates such as crystalline wafers, plasma sprayed silicon and ceramics.
- Development of special ceramic substrates for film silicon applications and adapted solar cell concepts.





ECN, the Netherlands Energy Research Foundation,

is an independent organisation for research and development in the field of energy. ECN focuses its activities on the needs of industry and government through target-oriented development and transfer of knowledge and the use of innovative technology. ECN strives for a reliable, environmentally sound and cost-effective energy economy.

ECN Solar Energy operates internationally from a firm basis in The Netherlands. An ambitious government provides budgets for R&D and market development that compare favourably to those of all other countries active in PV. The goal of the national PV program is to reduce electricity cost from PV by a factor of 3 and to install at least 100,000 PV roofs within a decade. ECN plays a key role in the achievements of these goals.

Solar Cells and Modules,

with its highly trained staff of 40 people, offers new processes, technologies and cell designs which are available for transfer and implementation on lab-scale, pilot-scale and production scale. Customers may also make use of the ECN processing and characterisation facilities, optimisation studies of production, and computational design of cells. As a fully private, independent organisation, ECN can work on a non-disclosure and exclusivity basis. The combination of our skills, experience, and facilities makes ECN a perfect partner in joint R&D activities.

Three main areas currently dominate ECN Solar Cells and Modules work:

- Crystalline silicon solar cells: development of low-cost and high efficiency solar cells for mass production by introducing new cell and module designs, new processing and by improving current processing.
- Inorganic thin-film cells: development of inexpensive and fast methods to grow silicon films on ceramic substrates.
- Organic thin-film solar cells: development of reproducible production processes on pilot line scale for dye-sensitised solar cells, research on device aspects of organic solar cells based on conductive polymers.

Processing Competence

- Use of Design of Experiments for process optimisation with minimum effort.
- Process control using lifetime change during processing.
- Metallisation using dedicated screen and stencil printing, and infrared firing.
- Electrical interconnections by tabbing using modern techniques such as PGRS, ultra-sonic and infrared soldering.
- Reflection reduction by wet chemical etching and texturing techniques.
- Advanced surface and bulk passivation and silicon nitride anti-reflection coating using in-line remote plasma enhanced CVD.
- Dedicated sealing and screen printing equipment for reproducible processing of organic solar cells.
- Development and production of pastes for functional layers of dye sensitised solar cells.
- Unique semi production scale facilities for processing of dye sensitised solar cells.
- Semi-automated Liquid Phase Epitaxy apparatus, zone-melting recrystallisation and metallisation schemes for thin film crystalline silicon solar cells.

Characterisation Competence

- Solar cell calibration according to ASTM standards, including mismatch factor calculation, spectral response and IV-curve measurement.
- Doping profile measurements with Stripping Hall and CV-profiling.
- Combined localised lifetime, short circuit current, and contact resistance measurements to map material and device properties at different stages of processing.
- Surface state density measurement to optimise surface passivation.
- Facilities for lifetime testing of indoor and outdoor organic solar cells.

Modelling Competence

- Design and optimisation of refined front and rear side metallisation patterns.
- Light coupling calculations using ray tracing for textured surfaces and thin films.
- Two and three-dimensional modelling of solar cells using an extensive semiconductor simulation package.

