

# Solar Energy

## Measurement Equipment

### Material characterization

ECN

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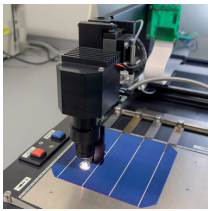
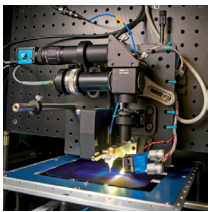
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[ecn.nl](http://ecn.nl)

Brand/Type	Description	Application
Filmetrics	Angle dependent reflectance	Range 280-1100 nm, flat, thin (<0.3 mm) sample
CV-MOS	Fixed charges and interface states	
DekTak	Profilometer	
Ellipsometer (Sentech)	Optical constants (n,k) of layers	Range: 280-1700 nm
Ellipsometer (Woollam)	Optical constants (k,n) of layers with flat and structured surfaces	Range: 280-1000 nm
Emission	Indicative only	Range: 400-1600 nm
Kelvin Probe	Workfunction (conductive), surface potential (isolating)	
Raman (Hariba/Reneshaw)	Vibrational, rotational modes of atoms	512-633 nm, >150 cm <sup>-1</sup>
Reflectance	Integrating sphere	400-1600 nm, sample < 20 cm
Resistomat	Accurate determination of electrical resistances	>1 mOhm
Transmission VIS-IR	Integrating sphere	400-1600 nm, sample < 20 cm
Transmission UV-VIS	Spectrophotometer	280-1100 nm





## Cell and module characterization

Brand/Type	Description	Application
Doped layer characterization	Hall, Sheet resistance, ECV	
Metal line resistance	BzB, TLM, Corescan	
Minority carrier lifetimes	QSSPC, uPCD, luminescence, DLIT	~300 K
Solar simulator	WACOM, Neonsee, Atlas, Pasan, Halm, Eternal Sun, Spire	Solar cells
Spectral responses	SR, LBIC	Solar cells
THz	Rheet resistance mapping, diffused and poly-Si fingers, Selective emitter study, Edge effects of B and P diffusions, Laser doping/ablation, material quality checks	Fast scanning (5ms/pixel), Quantitative Rsh measurement (0.1-10000 Ohm/sq), Non-destructive (contactless), High resolution (qualitative: 10um, quantitative: 150um)
Climate chambers	Damp-Heat, Thermal cycle, Humidity freeze	Sample size: 30x30x25 cm to 200x200x200 cm
Thermal shock		-70 - +200 °C, 32x15x23 cm
UV testing (Suntest XXL)	UV stability testing according to IEC 61215-2 (2016)	

## Theoretical modeling

Brand/Type	Description	Application
Silvaco Atlas	2D and 3D device simulator that performs DC, AC, and transient analysis for silicon, binary, ternary, and quaternary material-based devices. Atlas enables the characterization and optimization of semiconductor devices for a wide range of technologies	
Scout/Code	Optical simulation software	
Ray-tracing	Optical simulation based on ray-tracing	
COMSOL	Multiphysics simulator. Thermal, mechanical, electrical simulations.	

