# Efficiency and durability of photovoltaic modules: experimental methods and computational modelling

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## AIMS AND OUTLOOK

**Development of an integrated experimental-computational methodology to assess the durability of photovoltaic (PV) modules for forensics inspections and material qualification by considering the problem of microcracking in polycrystalline Silicon (Si).**

## INTRODUCTION

**PV modules can be efficiently integrated in buildings (Fig. 1). The pay-off time of this technology is 3 years and the solar energy conversion efficiency is still low, although it has been increased up to 20%. Warranty specifics of producers expect significant power-losses due to microcracking during the lifetime of PV modules (Fig. 2).**

**Fig. 1: examples of PV installations.**

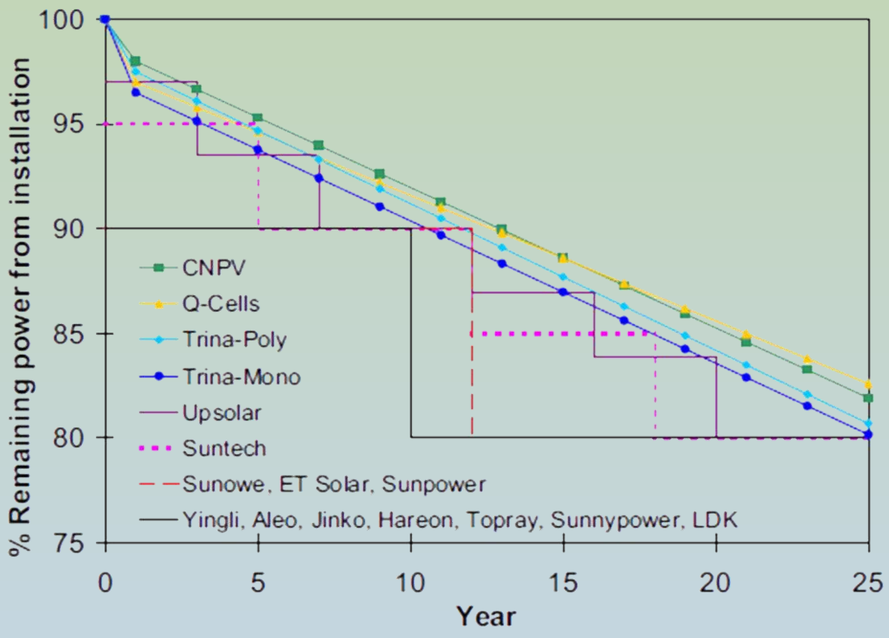


**Fig. 2: comparison of warranty specifics.**

## EXPERIMENTAL METHODS

**Microcracking can be qualitative assessed in situ by inspecting PV modules with a thermocamera (Fig. 3a). In the laboratory, a higher resolution can be achieved by using the electroluminescence technique (Fig. 3b).**

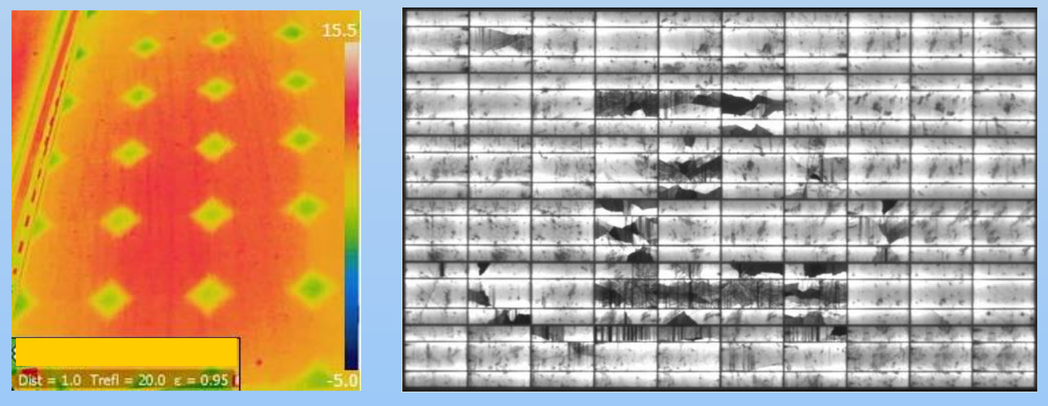


**Fig. 3: (a) Thermocamera image. (b) Electroluminescence image showing electrical inactive areas (in black) due to microcracking [2].**

## COMPUTATIONAL APPROACH

**An innovative multi-scale and multi-physics FEM is proposed [2] to simulate the effect of microcracking on the electric response of the module (Fig. 5). The electrical inactive areas (Fig. 6a) and the I-V curve of PV modules (Fig. 6b) can be predicted for any kind of loading scenario.**

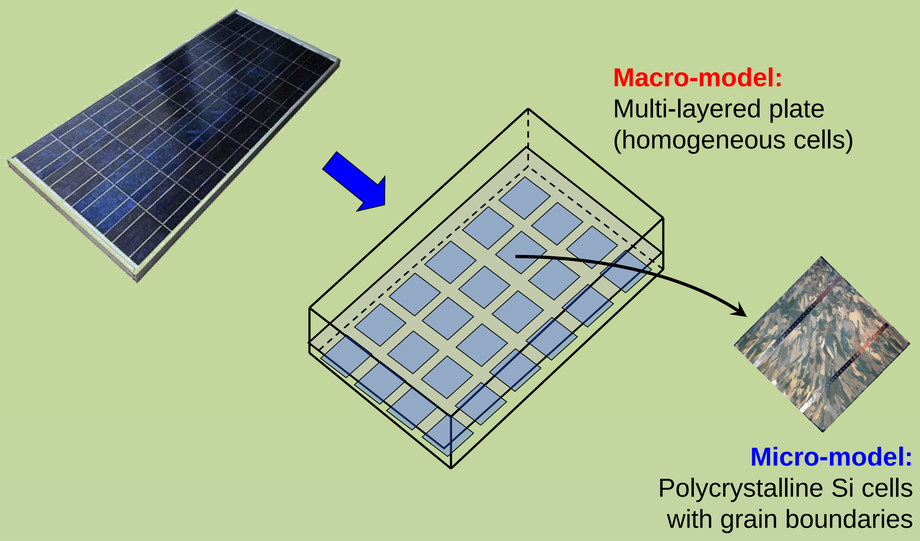


**Fig. 5: multi-scale FE computational model.**

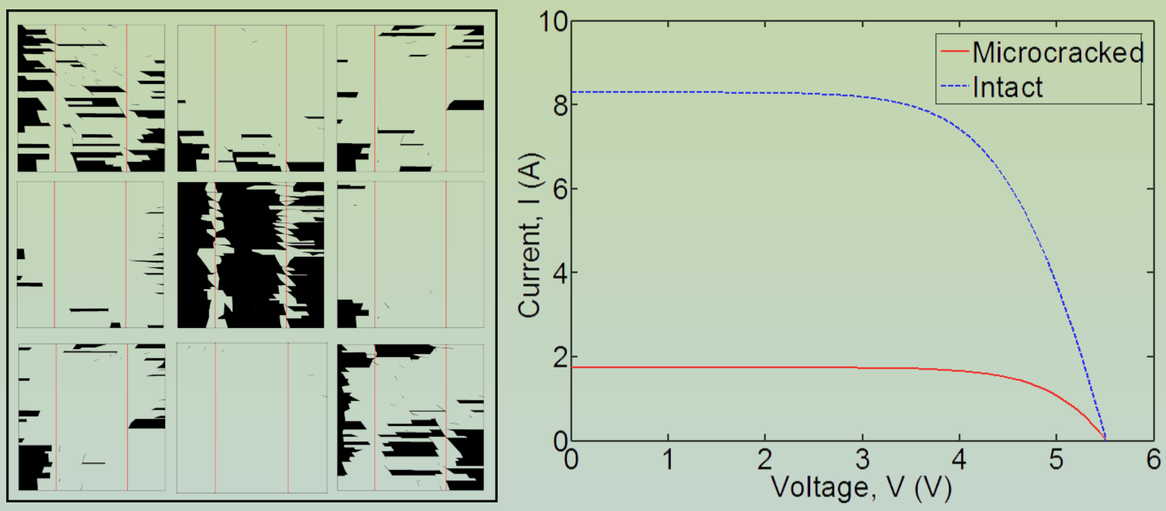


**Fig. 6: (a) simulated microcracked areas in a 3x3 PV module subjected to snow pressure and related I-V characteristics (b).**

## REFERENCES

**[1] S. Kajari-Schröder, I. Kunze, U. Eitner, M. Köntges (2011) Solar Energy Materials and Solar Cells, 95:3054–3059.**

**[2] M. Paggi, M. Corrado, M.A. Rodriguez (2012) Composite Structures, in press, DOI:10.1016/j.compstruct.2012.08.014.**

## ACKNOWLEDGMENTS

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