Australian Government
Australian Renewable Energy Agency

ARENA

Lessons Learnt

Lessons Learnt Report: *CTM analysis*

Project Name: *Photovoltaic Modules for the Australian Environment (PV-MATE)*

Knowledge Category:	Technical
Knowledge Type:	Technology
Technology Type:	Solar PV
State/Territory:	Canberra ACT, Adelaide ACT

Key learning

We found that depending on the initial quality of the cell surface the losses generated by module embedding vary strongly. In general as higher the quality of the embedded cell texture I higher the losses generated by the embedding material.

Implications for future projects

We find that the module embedding causes up to 12Watt loss in module power. This is more relevant as higher the initial cell efficiency in air is.

Knowledge gap

We determine the impact of module embedding materials on the power output of a solar module for varying industrially common cell types.

Background

Objectives or project requirements & Process undertaken

Embedding solar cells into a solar module has an impact on the amount of light which can be absorbed by the solar cell. In a first matter it generates optical losses by absorbing and reflecting the irradiated sun light in or at the covering layer (e.g. glass and EVA). But there are also optical gains, which arise by embedding the cell in a material with an intermediate refractive index, which lies between the one of air and the cell surface. In this research we show that this coupling gain is strongly influenced by the reflectance of the cell measured against air. We investigate several industrial available solar cells types, which vary strongly in their surface structure (iso textures, inverted and random pyramids) and in their efficiency. We find that the change in short circuit current (ΔI_{sc}), generated by embedding the solar cells in the same standard encapsulant (EVA) varies between +4.8% for multi crystalline to -6.5 % for high efficient IBC solar cells. Further we demonstrate how this impacts the cell to module ratio (CTM) by calculating the resulting module power for an industrial sized module configuration. Based on this we discuss the CTM ratios which can be achieved for a certain cell technology.

Supporting information

Poster at APVI 2015 in Brisbane: I. Haedrich et al.: "Cell to Module (CTM) Ratios for Varying Industrial Cell Types"

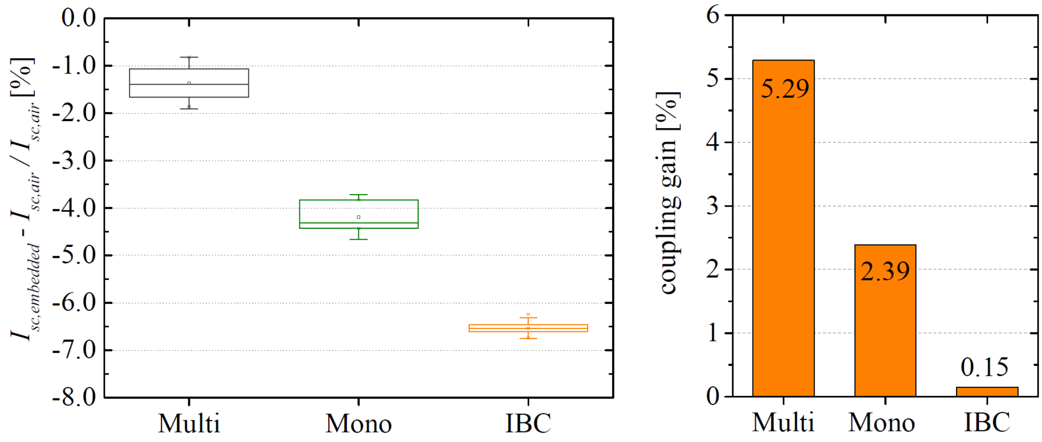

Fig.1 left: change in short circuit current (ΔIsc) measured before and after embedding of three different solar cells; right: therefrom calculated coupling gain

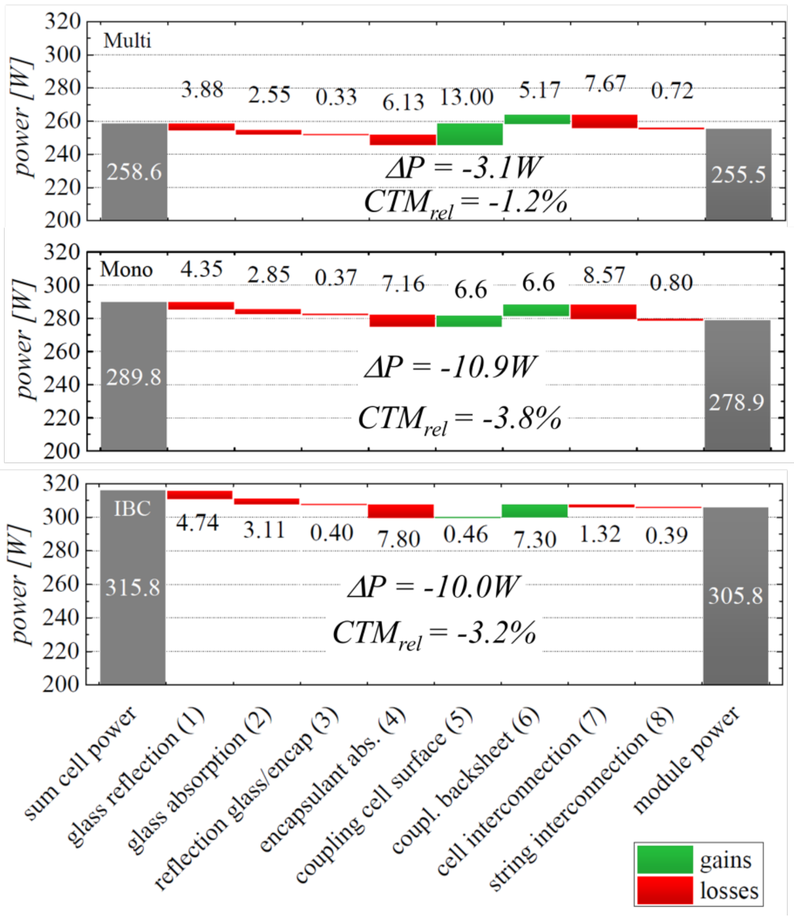

Fig 2: Calculated module power and CTM gains and losses for the investigated module types