R&D for Advanced Industrial Solar Cells and Modules

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The calls for clean energy have built a fast ramping solar industry. China is playing a key role in this global opportunity. In this paper, we summarize the R&D activities for advanced solar cells in our lab for recent years. Firstly, the principles of three leading solar cells (H-pattern, heter-junction, and all back-contact solar cells) are reviewed and loss mechanisms are analyzed theoretically. Then the analytical and numerical analyses are carried out to match with the industrial practices. In addition, photoluminescence (PL), electrical luminescence (EL),etc are applied in the correlation study between the opto-electrical and micro-structural properties of the solar cells. The equipments are re-designed based on the thermal and fluid field modeling to optimize the crystalline growth. The quality of the materials is also improved by the micro-structural engineering technologies aid with crucible surface treatment or special seed crystal.

In terms of the structural optimization and thin film layer engineering, the selective emitter, multi-layer SINx and AlOx passivaiton optimization have been developed with priorities. The multi-crystalline solar cell in our lab have achieved an efficiency of 19.7%. last but not least, the performance of the solar module is further optimized by optical and electrical design, as well as the packaging materials design. Thanks to those collectively application of the above technologies, our Trina Solar Honey module are testified by TUV, the international authority for solar module testing, of reaching 273.4W(60 cells， 156mm x 156mm size). This corresponds to a window efficiency of 18.7% and broke the record held by German companies. Later in May of 2012, the record was further refreshed by our honey Ultra module, which reached a number of 284.7W, corresponding to a window efficiency of 19.7%. Looking forward, We target to develop the highly efficient and highly reliable all back-contact solar cells and film-crystal heter-junciton solar cells with a efficiency > 21% in production.