Technology Roadmap for Crystalline Silicon PV: First Results of German Working Group

German Working Group

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Abstract
Leading German crystalline silicon (c-Si) solar cell manufacturers currently prepare a technology roadmap for c-Si photovoltaics (PV). The aim of this roadmap is to inform suppliers and customers and set a basis to intensify the dialog about required improvements and standards. This publication reports about the roadmap activity and first results. A preliminary roadmap will be published in March 2010.

Between 2011 and 2014 new technologies need to be implemented in production. Details of requirements for advancement of c-Si solar cell manufacturing will be described and technological barriers will be identified. This information shall enable future growth and significant cost reduction per piece.

Approach
To give guidance the roadmap focuses on essential developments for long term research. The topics are split up in three areas: materials, processes and products.

Materials
Future wafer dimension developments and material trends are described. A replacement of some materials will be necessary to secure availability, avoid environmental risks, reduce costs and increase efficiencies.

Processes
To reduce production costs new technologies, materials and highly productive equipment including SPC are needed. The cost of ownership has to be reduced per piece not only per Wp since an increase of the cell efficiency on its own is not sufficient to reach the overall cost targets. By describing fundamental requirements the roadmap will be the guideline to support these developments.

In order to speed up the introduction of new technologies and tools in PV production, tool manufacturers need to develop alpha and beta tools internally before introducing first production tools into the market. This is absolutely comparable to the semiconductor industry / ITRS road map.

Products
Important features of the c-Si solar cell will change over next years. Due to this fact, the roadmap will determine and take into account future wafer and module developments. Issues like wafer dimension and cell architecture are defined in the roadmap.

Materials

Wafers will become thinner and larger. Figure 1 shows thickness reduction to 100 µm by 2020. Larger wafer are expected for 2015.

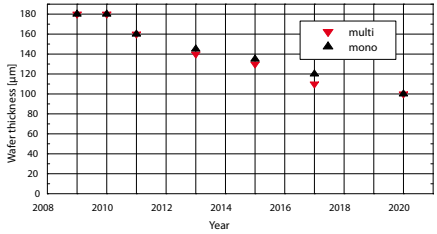

Figure 1: Waferthickness [µm]

Processes

Most important key figures are yield loss, front side metallization, recombination losses front and rear side. For the process two kinds of information are given. In graphs the expectation for process and solar cell parameters up to the year 2020 are shown. Additionally color marking indicates the state of the technology today.

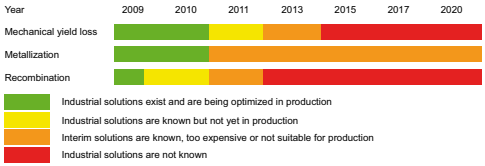

Table 1: Color marking of the processes

Figure 2 shows that mechanical yield loss is expected to decrease to below 1% by 2020. Note that this includes changes to thinner and larger wafer at the same time.

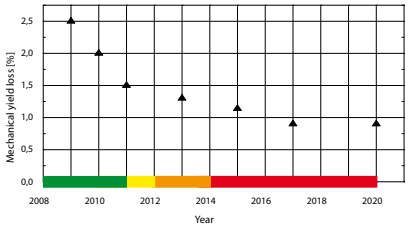

Figure 2: Mechanical yield loss

Front metallization is a key process in production of c-Si solar cells. A reduction of the finger width without significantly lower finger resistance is needed. Further more the contact to a shallow emitter has to be guaranteed. Figure 3 shows that up to 90 µm finger width seems to be feasible with current technology. But from 2011 on new economically feasible solutions are required.

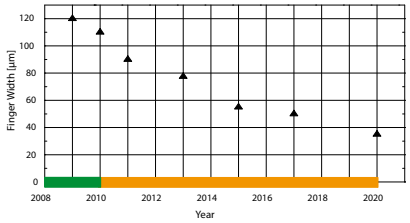

Figure 3: Finger Width

Recombination losses of front and rear side have to be reduced. The appropriate parameter is the recombination current J0 shown in figure 4. A new process with lower process costs than current technology is needed by 2011/2012.

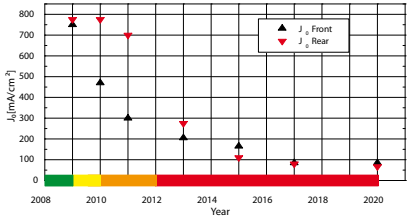

Figure 4: Recombination

Products

One option to reach higher module efficiencies and lower module production costs are modules based on rear contact cells. The fraction of produced rear contact cells will increase according to figure 5.

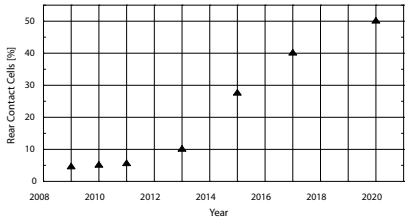

Figure 5: Rear contact cells as fraction of production

Outlook

Based on the first results presented here, the leading German cell manufacturers will continue their work and publish a preliminary roadmap for c-Si solar cells in March 2010. Topics like wafer size require a cooperation between suppliers, cell manufacturers and costumers. Also an international roadmap activity is the adequate approach for the future. To set up a new structure we will discuss with SEMI and EPIA.

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