MOTIVATION

Hot melt screen-printing (HM) is a new and promising technology for solar cell contact formation. In HM screen printing, metal pastes with melting points of 50–80°C are used in combination with specially designed screen-printers containing heated screens, squeegees and print tables, see figure 1. Among the advantages of this technology over conventional screen-printing are the possibility of making thin front contacts with high aspect ratios and since hot melt inks solidify immediately after a solar cell is removed from the print table, driers are no longer required in a screen-printing line, reducing investment costs.

METHODS

This work describes a study of HM screen printing of front contacts. The structure and electrical properties of front contacts were studied as a function of print speed, print pressure, squeegee and print table temperature and the composition of the metal ink. The line width, height and uniformity of the front contacts were characterized using interferometry, scanning electron microscopy and optical microscope. To accurately determine the variation in finger width, which is an important indicator in this study, a plug-in module to ImageJ was developed. The contact resistance between emitter and front contact were determined using CoreScan. The efficiency of solar cells printed with HM screen-printing, were determined by IV-measurements.

RESULTS

Fig. 3. Finger width as a function of print speed (left) and print table temperature (right)

Fig. 4. Height profiles of printed fingers using different print table temperatures (left). Optical microscope image of a finger opening on a 325 mesh/inch screen with mesh angle 22.5° (right). The black line marks a typical position for a height scan like the ones to the left.

CONCLUSIONS

Hot melt screen printing is a promising upcoming technology. The results presented here have shown it is possible to print lines with higher aspect ratio compared with standard screen printing. Optimum parameters for printing seems to be high print speed in combination high squeegee temperature. There is a trade off between the height and width of the finger lines when adjusting the table temperature. High table temperature gives uniform and high fingers, but results in wide lines. Low print table temperature, on the other hand, gives narrower fingers, but non-uniform height. Firing with fingers facing down at high belt speeds results in shrinking of line width between 15-20%. At present the best efficiency results from HM screen printing are at par with standard printed solar cells. There are still some unsolved stability problems related to clogging of screens over time, shunting of screen under heating and during print stops, and screen design.