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HEAT TRANSFER ESTIMATION DURING LASER-ASSISTED METAL-INDUCED CRYSTALLIZATION OF AMORPHOUS SILICON FILMS*

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Elaboration of new methods of polycrystalline silicon films formation on low-melting substrates is of great interest today [1]. Using of such substrates (glass or plastic) has two main advantages: decrease of the end product cost and extension of the possible application toward wearable devices. An original approach to amorphous silicon film crystallization on glass [2] and polyimide [3] substrates was developed by our group. This approach using common fiber 1064 nm laser and thin metal layer for laser power absorption on the top of the a-Si film to be crystallized. Applying Al or Ni as a metal for absorption layer the temperature of c-Si formation can be lowered due to metal-induced crystallization mechanism [4]. This work is devoted to developing of simple estimation approach of heat energy transferring to amorphous silicon layer and underlying substrate during laser-assisted metal induced crystallization.

We considered a simple static case of heat distribution between metal absorption layer and amorphous silicon film. Estimation was done for 1000 nm thick a-Si film with 300 nm Al absorption layer. Laser processing parameters were the following: beam diameter 20 μm, pulse power 0.2, 0.4 and 0.6 W and the laser scanning rate was varied from 25 to 250 mm/s. To take into account speed variation the laser fluence was calculated according with the work [5]. Taking into account material constants for Si and Al and the laser processing parameters it is possible to evaluate a maximum laser scanning rate for Al layer completely evaporized that is near 200 mm/s. Decreasing the scanning rate leads to increase of excessive heat energy transferred to a-Si film. Dependence of excessive energy vs. scanning speed for three levels of pulse power is shown oh Figure 1.

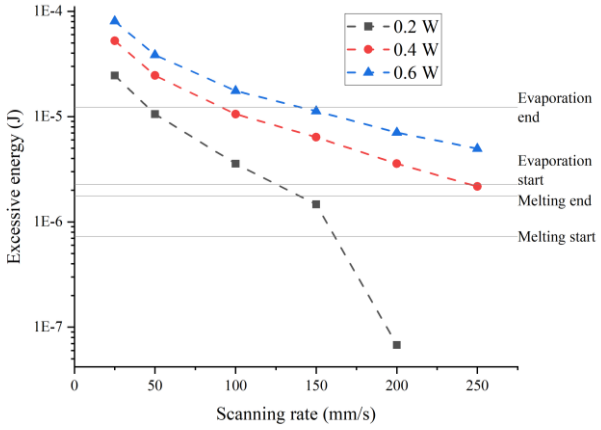

Figure 1. Excessive heat transferred to a-Si film for varied scanning rate and pulse power

It can be concluded that optimal crystallization conditions are 0.2 W pulse power and 150-200 mm/s scanning rate. The a-Si film start to melt but its evaporation is not occurred yet.

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