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A — 6 — 5 The use of selective annealing for growing very large grains in SOI films

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The selective annealing technique (laser annealing under patterned antireflecting coating) has been successfully applied to the growth of very large (20 x 300 µm) silicon single crystals. The grain boundary location is controlled by a photolithographic step.

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A considerable amount of work has been devoted to increasing the grain size in silicon films, the ultimate purpose being to obtain a thin single crystal sheet of silicon on insulator. The C.W. laser annealing technique, among others, has rarely been able to provide single crystals more than 5 x 20 µm in size. Gaussian beams are known to provide, after scanning, chevron-like recrystallization patterns, while shaped beams (crescent, doughnut shape) have shown to be able to grow somewhat larger grains.

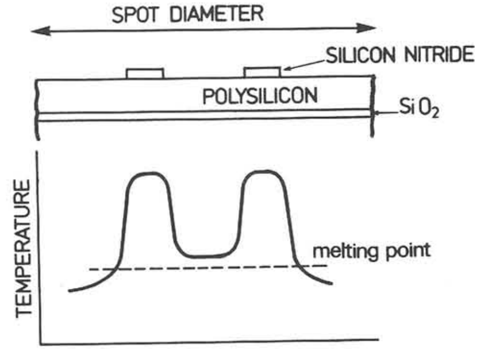
The key of the problem is the cooling down mechanism after laser exposure. A cooling from the borders of the scan line induces a random nucleation with competition between the crystallites. A single crystal can be grown and pulled over a large area only if the freezing silicon is cooled exclusively by the already grown single crystal. To prevent random nucleation from the borders from competing with the single crystal growth, the freezing silicon has to be bordered by "hot walls". The technique developed here uses antireflecting stripes of silicon nitride to induce these "hot walls" in a polysilicon layer deposited on a 1000 angström thick SiO_2 layer.

Figure 1 illustrates the concave temperature profile induced in the Poly-Si layer (the spot size is supposed to be large with respect to the stripe width an spacing). Figure 2 illustrates the nucleation and single crystal growth processes. The laser power is increasing from right to left (right to left scan). As long as the power remains beyond a given threshold, the poly-Si melts under the antireflecting stripes only. Once the power is large enough, the silicon melts in between the stripes. The freezing silicon at the rear of the laser spot grows epitaxially form the already formed single crystal.

The very first seed of each single crystal grows with an aperture of ± 90° (scan speed of 20 cm/s) until it comes in contact with the neighbouring growing grain. This leads, by virtue of symmetry, to straight grain boundaries under the nitride stripes.

In conclusion this technique allows to grow very large grains (20 x 300 μm) of silicon on insulator. The grain shape and the grain boundary location are controlled by highly reproducible photolithographic means. This technique looks very promising in the field of SOI devices, since the single crystal location is fully controlled by lithography.

Figure 1 :



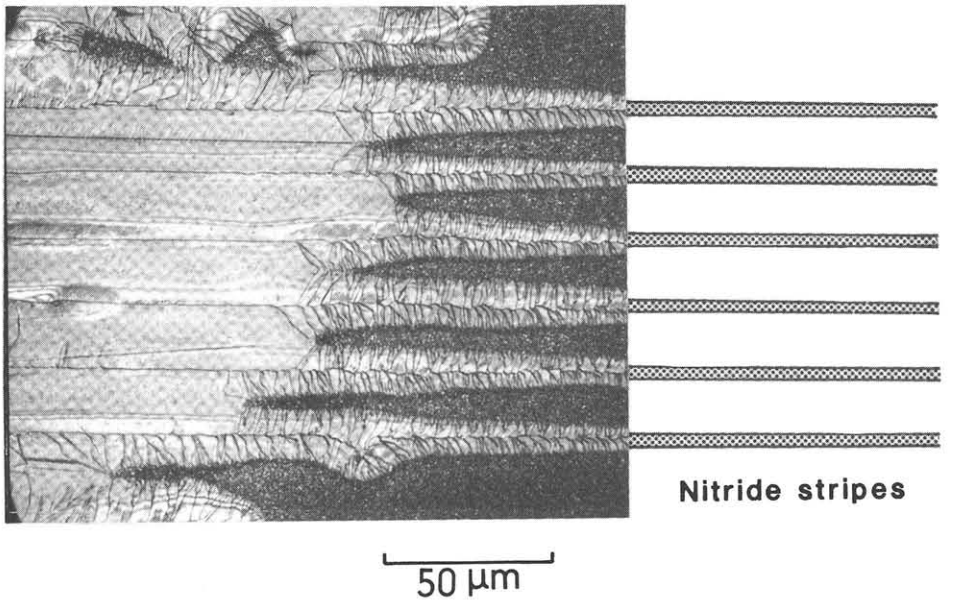


Figure 2