CW Laser Lateral Crystallization (CLC)

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The low-temperature poly-Si TFT performances have become comparable to those of the single-crystalline Si MOSFET's by using CLC. High throughput of CLC is also achieved by the selective and simultaneous irradiation of divided laser beams.

The CW laser Lateral Crystallization (CLC) of amorphous Si by a 532nm diode-pumped solid-state laser has been developed for low temperature poly-Si TFTs on glass substrate [1]. The mobilities of CLC TFTs are greater than those of the widely used pulsed Excimer Laser Crystallization (ELC) by a factor of 2-3. CLC is a technology to realize a sheet computer, where many kinds of intelligent circuits, as well as display drivers, are integrated in the same glass or plastic substrate with the pixel array of LCD or EL display, as shown in Fig.1.

In the CLC process, molten region moves laterally with the scanning CW laser spots and the crystal growth is induced laterally and continuously, resulting in extended large grains having nearly parallel grain boundaries, as shown in Fig.2. The single crystalline grain size exceeds that of ELC by a factor of 10 to 100. The laser power is 2-10 W, the scanning speed 40-200 cm/s, the amorphous silicon film thickness 40-250 nm, the buffer SiO2 layer 400nm between the amorphous Si and glass, and the width of lateral growth region by a single scan 20-300 um. Cross sectional TEM of the CLC film verifies that the surface of the CLC film is flat and no damage is induced in the underlying glass. The CLC poly-Si film is qualitatively same kind of film as that was obtained by unseeded CW laser crystallization on Si-wafer to make 3-D integrations [2], but the scanning speed is much faster, the molten width wider, and the crystallized film thickness thinner than those on Si-wafer.

The obtained mobilities of CLC poly-Si TFTs are 570 and 200 cm2/Vs for n- and p-channel TFTs, respectively. These values of the CLC poly-Si TFTs are comparable to those of the CLC single-Si TFTs [3] and the single-Si MOSFETs. The high TFT circuit performances on glass have been confirmed by fabricating LCD panels and various TFT circuits such as 100 ps propagation-delay ring oscillator, 270 MHz clock shift registers, 1 k bit SRAMs, level-shifters, etc.

High throughput of the CLC is obtained by the simultaneous and selective irradiation of the divided and multiplexed laser beams to each TFT active area in pixel, as shown in Fig.3. The net crystallization throughput becomes larger than that of ELC, as shown in Fig.4. CLC is also suitable to a large size TV as well as a mobile sheet computer because the throughput increases with the pixel pitch due to the selective crystallization. The CLC scanning system is scalable and the substrate can be easily extended to the 7th generation size.

References

[1] N.Sasaki, et al., SID'02 Digest Tech. Papers, p.227 (Boston, May, 2002).
[2] N.Sasaki, et al., Proc. Solid State Devices Conf. '83, Late News A-3-7LN (Tokyo, Aug., 1983).
[3] Y.Sano, et al., IEEE IEDM'02 Tech.Digest, p.565 (San Francisco, Dec., 2002).

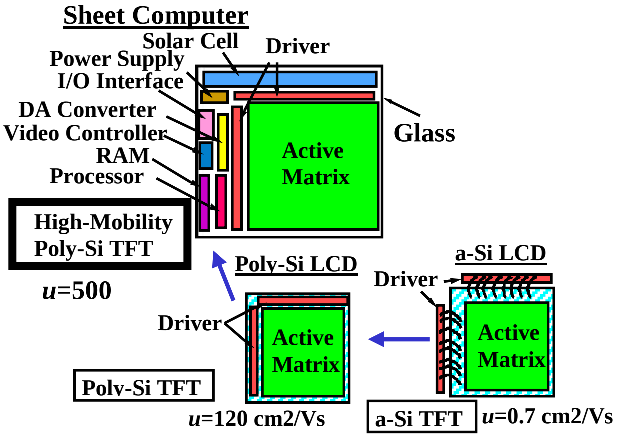

Fig.1. Evolution from LCD panels to Sheet Computers.

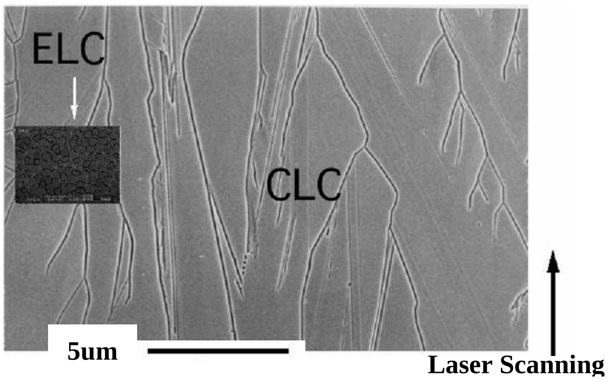

Fig.2. SEM grain boundary patterns of CLC and ELC after delineation etching.

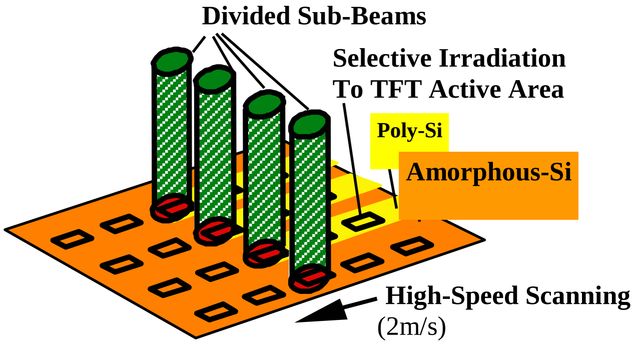

Fig.3. CLC selective irradiation by the divided laser beams.

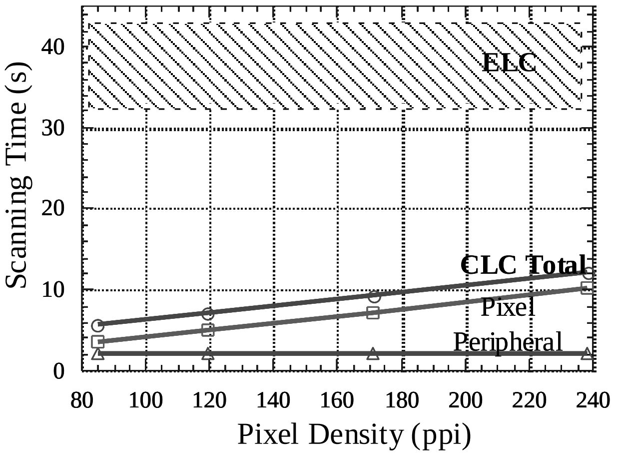

Fig.4. Calculated net scanning time of CLC and ELC for each 15 inch panel. The width of peripheral region is 2 mm. The peripheral region is crystallized by 8-beam simultaneous irradiation at a 250um lateral width for each beam and a 50cm/s scanning, and the pixel area is by 32 divided sub-beams at a 30um lateral width for each beam and a 200cm/s scanning.