Abs. 962, 206th Meeting, © 2004 The Electrochemical Society, Inc.

Sequential Lateral Solidification of Sputter Deposited Amorphous Silicon Thin Film and Transistor Characteristics

Yong-Hae Kim, Choong-Heui Chung, Choong-Yong Sohn, Jung Wook Lim, Sun Jin Yun, Dae-Won Kim, Dong-Jin Park, Yoon-Ho Song and Jin Ho Lee
Basic Research Lab., Electronics and Telecommunications Research Institute
161 Gajeong-Dong, Yuseong-Gu, Daejeon, 305-350
Korea

The interest in the low temperature poly-Si (LTPS) thin film transistor (TFT) stems from its much higher mobility than α-Si TFT (up to 200 times greater), which enables it to be used for the full integration of both the drive circuits and the pixel TFTs in a monolithic CMOS technology [1]. Because readily available transparent plastic substrates have temperature-resistance up to 200 ^{o}C, it is required to reduce the process temperature below 150 ^{o}C. D. P. Gosain et al. deposited α-Si films by sputtering an intrinsic Si target in an He atmosphere. The film sputtered in He does not contain hydrogen, but contains a small amount of helium which is effused out by the leading edge of the laser beam resulting in a large grain poly-Si film with grain size of 300-500 nm [2].

The 80 nm α-Si film is deposited on 1μm SiO_2 buffer/silicon substrate in an RF magnetron sputtering system. Sputtering is performed with a high purity Si target in an argon working gas. A background pressure of 1.0×10-7 Torr is generated in the sputtering chamber prior to the Si deposition. The target to substrate distance is fixed at 6.4 cm and the substrate holder is maintained at room temperature. The α-Si films are deposited in a 0.65 mTorr~15.5 mTorr argon pressure range by changing gas flow rate and the RF discharge power is 400W.

Figure 1 shows the Ar content within the α-Si film and the maximum laser energy density over which the α-Si film is damaged by explosive Ar gas effusion. Although the Ar content within the α-Si film is decreased by increasing the working gas pressure, the α-Si film grown at 2.7 mTorr shows the highest resistance upon damage with 792 mJ/cm^2. The films prepared at low pressure exhibit little surface morphology and a densely packed structure which is indicative of a zone T dense structure . The most resistant α-Si film for Ar gas effusion damage may be determined by competition between the film density and the argon gas concentration

Figure 2 shows the Ar content within the α-Si film as the consecutive laser annealing. The argon content in the α-Si film analyzed by Rutherford Backscattering Scattering (RBS) is reduced from 1.02 % to 0.7 % by consecutive laser annealing from 70 mJ/cm^2 to 500 mJ/cm^2. Figure 3 shows (a) the plane and (b) the cross sectional TEM image of the SLS crystallized poly-Si film of sputter deposited amorphous film. Unlike the SLS crystallized poly-Si film of LPCVD deposited amorphous film, crystallized poly-Si film is composed of multi grain both in lateral and in vertical direction.

Figure 4 shows (a) the nMOS and (b) the pMOS transfer characteristics and (c) the nMOS and (d) pMOS output characteristics. The ULTPS TFT with W/L=30μm/30μm shows excellent performance with on/off current ratio of 4.20×10^6 (nMOS) and 5.7×10^5 (pMOS), high mobility of 114 cm^2/Vs (nMOS) and 42 cm^2/Vs (pMOS), small Vth of 2.6 V (nMOS) and -3.7 V (pMOS), and swing of 0.73 V/dec (nMOS) and 0.83 V/dec (pMOS).

References

[1]A. T. Voutsas, *Appl. Surf. Sci.*, vol. 9602, pp. 1-13, 2003.
[2] D. P. Gosain, J. Westwater, and S. Usui, in Proc. AMLCD, 1997, pp. 51-54.

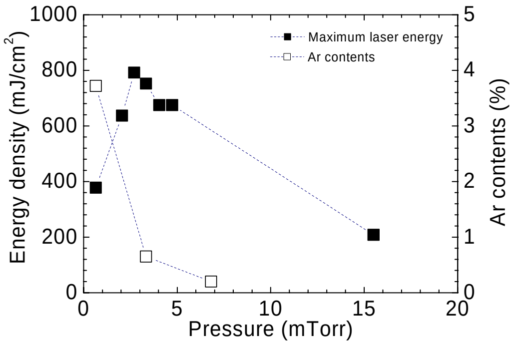

Fig. 1. The Ar content within the α-Si film and the maximum laser energy density over which the α-Si film is damaged by explosive Ar gas effusion with pressure variation.

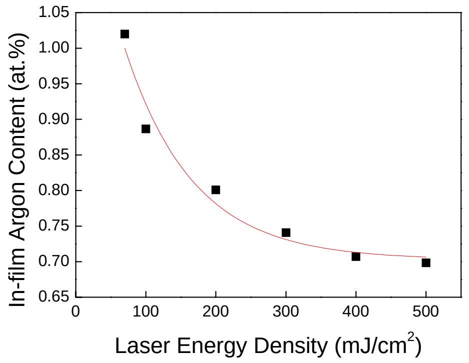

Fig. 2. The Ar content within the α-Si film as the consecutive laser annealing.

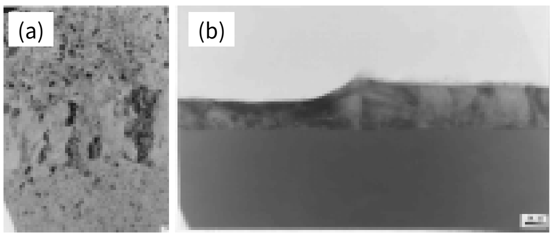

Fig. 3. (a) The plane and (b) the cross sectional TEM image of the SLS crystallized poly-Si film of sputter deposited amorphous film.

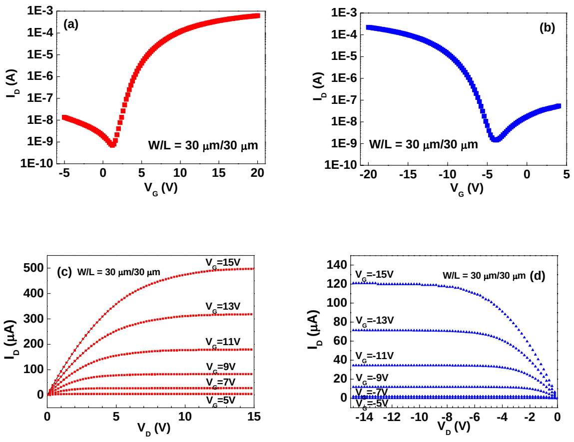

Fig. 4. Transfer characteristics of (a) nMOS and (b) pMOS. Output characteristics of (c) nMOS and (d) pMOS. Channel length and width are 30 μm and 30μm.