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Stress Induced Orientation Control by Metal Induced Lateral Crystallization

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High performance poly-Si TFTs are demanded for integrating further with controllers, signal processor and memory. Metal-Induced-Lateral-Crystallization (MILC) can produce <110> orientation poly-Si due to the small mismatch (0.4%) of the lattice constant between $NiSi_2$ and <111> direction of Si. During lateral growth (110) surface orientation becomes dominant. However, it is reported that MILC can achieve <100> orientation as well[2)]. The physical principal of orientation control during MILC process is still not clear. In this research, we investigated the relationship between stress and different orientation control during the MILC process. Reaction $NiSi+Si \rightarrow NiSi_2$ is known to result in a total volume contraction of ~12%[1)]. This contraction will result in tensile stress in the film. However due to the Poisson ratio and the pattern shape, the stress distribution over a large area is not homogeneous. Fig.1 shows simulation result of the stress distribution of the MILC with a rectangle shaped Ni pattern with a-Si film thickness of 250nm. Fig.2 is a microscope picture of micro-Raman measurement. We see wave number near the corner is lower than that away from the corner which indicates that the Ni corner induces a higher tensile stress. The result is in agreement with the stress simulation. We calculated the tensile stress difference from Raman shift by using the relation: using the relation: $\sigma\ (Pa) = \Delta\omega\ (cm^{-1})*5*10^8 = 250MPa$[2)]. The higher tensile stress at the corner increases the surface energy of the film. Then the higher surface energy caused (100) orientation control at the corner during Ni mediated lateral crystallization. Fig.3 is a reference from previous paper which shows the relationship between different orientations and the surface energy in secondary growth of Si[3)]. We see higher surface energy can change orientation to change from <110> to <100>. Fig.4 is an EBSD mapping of square Ni pattern. We can see the orientation starts to change from <110> (green) to <100> (red).In order to obtain <100> orientation, we designed the zigzag pattern of Ni. Fig.5 is an EBSD mapping of the zigzag Ni pattern. We see the <100> orientation grows explosively along the tips and between the corner there are still small portion of <110> which is caused by lower tensile stress during the MILC process. In this research, we investigated the relationship between stress and different orientation control during the MILC. Higher tensile stress can increase the surface energy which caused <100> orientation.

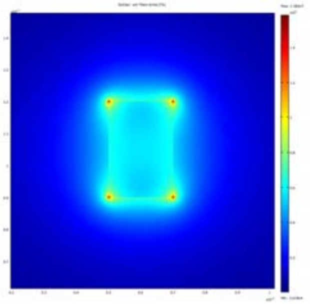

Fig.1 Simulation of the stress distribution after MILC

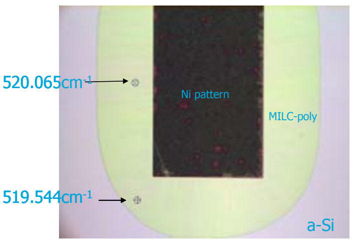

Fig.2 Raman measurement

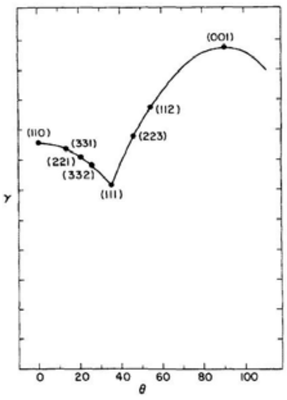

Fig.3 Surface energy as a function of orientation[3)]

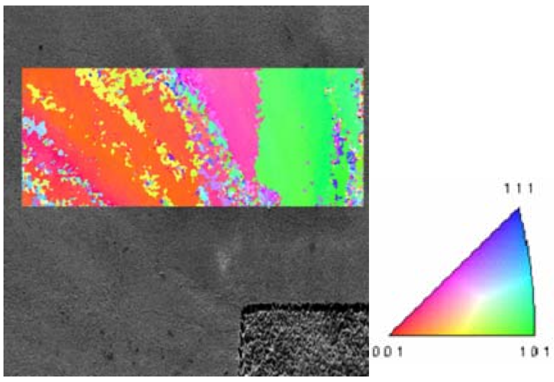

Fig.4 EBSD mapping of square Ni pattern

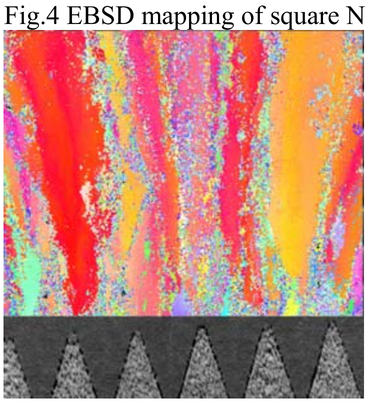

Fig.5 EBSD mapping of zigzag Ni pattern

References

1) F.M. D'Heurle, J. Mater. Res. 3, 167(1988) (the contraction of Ni silicides)
2) T. Chen, R. Ishihara, JJAP VOL.47.No.3,2008
3) C.V. Thompson. J. Appl. Phys, Vol.58 , No.2 (1985)