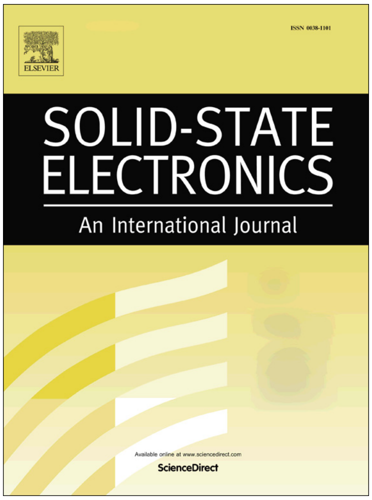

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PII: S0038-1101(16)30334-3
DOI: http://dx.doi.org/10.1016/j.sse.2017.03.011
Reference: SSE 7210

To appear in: *Solid-State Electronics*

Received Date: 13 December 2016
Revised Date: 23 February 2017
Accepted Date: 8 March 2017

Please cite this article as: Kim, H.Y., Seok, K.H., Chae, H.J., Lee, S.K., Lee, Y.H., Joo, S.K., Effect of Nickel Silicide Gettering on Metal-Induced Crystallized Polycrystalline-Silicon Thin-Film Transistors, *Solid-State Electronics* (2017), doi: http://dx.doi.org/10.1016/j.sse.2017.03.011

Effect of Nickel Silicide Gettering on Metal-Induced Crystallized Polycrystalline-Silicon Thin-Film Transistors

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Abstract Low-temperature polycrystalline-silicon (poly-Si) thin-film transistors (TFTs) fabricated via metal-induced crystallization (MIC) are attractive candidates for use in active-matrix flat-panel displays. However, these exhibit a large leakage current due to the nickel silicide being trapped at the grain boundaries of the poly-Si. We reduced the leakage current of the MIC poly-Si TFTs by developing a gettering method to remove the Ni impurities using a Si getter layer and natively-formed SiO_2 as the etch stop interlayer. The Ni trap state density (N_t) in the MIC poly-Si film decreased after the Ni silicide gettering, and as a result, the leakage current of the MIC poly-Si TFTs decreased. Furthermore, the leakage current of MIC poly-Si TFTs gradually decreased with additional gettering. To explain the gettering effect on MIC poly-Si TFTs, we suggest an appropriate model.

Keywords : Metal induced crystallization, thin-film transistors, gettering, leakage current

1 Introduction

Metal-induced crystallization (MIC) can be used to manufacture polycrystalline silicon (poly-Si) thin-film transistors (TFTs) intended for use in active-matrix flat-panel displays (AMFPDs). Poly-Si TFTs fabricated via MIC offer several advantages, including a low batch cost, simple fabrication process, highly uniform surface, and longitudinal large-grain size [1,2,3,4]. However, most of the AMFPD industries have adopted excimer laser annealing (ELA) because the leakage current (I_{leak}) of poly-Si TFTs fabricated via MIC is higher than that of poly-Si TFTs fabricated via ELA. Thermal generation, band-to-band (BTB) tunneling, Poole-Frenkel (P-F) emissive current through grain boundary traps, extended defects, and the resistive properties of undoped poly-Si have been suggested to be the possible origins of the I_{leak} [5,6,7,8,9]. On the other hand, MIC poly-Si TFTs showed a serious, extensive range of contamination of nickel silicide defects, which assists in thermal generation, BTB tunneling, and P-F emissive current. Some researchers tried to suppress the I_{leak} by implementing a lightly-doped drain, drain-off set, field-induced drain, and multi-gate structures to reduce the vertical electric field in the drain junction [10,11,12,13]. However, these techniques are not intrinsic solutions to ultimately achieve a low I_{leak}.

When metal is used as the crystallization catalyst source, MIC poly-Si TFTs will continue to have issues. Still, many attempts have been made to reduce contamination of nickel silicide to achieve a low I_{leak} [14,15,16,17]. Although these methods have effectively reduced the nickel silicide contamination of MIC poly-Si, high-performance poly-Si TFTs still cannot be achieved. Gettering method also has been studied to reduce Ni impurities in MIC poly-Si TFTs [18,19]. However, mechanism of nickel silicide gettering and its effect on MIC poly-Si TFTs remain unclear. So more studies are needed about effects of nickel silicide gettering on MIC poly-Si TFTs. In this study, we fabricated a MIC poly-Si TFTs by extracting the Ni and residual nickel silicide using a sacrificial amorphous silicon (a-Si) layer to apply a “Gettering” technique. Due to the different chemical potential, Ni and residual nickel silicide migrate to the sacrificial a-Si getter layer that acts as an extraction layer for Ni and nickel silicide. As a result, the I_{leak} of the MIC poly-Si TFTs decreased after gettering. We also suggest an appropriate model to explain gettering effect on MIC poly-Si TFTs.

2 Experimental details

A 100-nm-thick SiO_2 buffer layer was deposited on a compacted glass substrate via plasma enhanced chemical vapor deposition (PECVD). Then, a 80-nm-thick a-Si active layer was deposited via low-pressure chemical vapor deposition. On top of that, a 5-nm-thick Ni was deposited by direct current magnetron sputtering at 0.5 A. To trigger the MIC, the sample was annealed by furnace at 550 °C for 1 h in a H_2 ambient. After the