The new method of electron-beam lithography on HSQ at overlay writing

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Hydrogen silsesquioxane (HSQ) is one of the widely used negative-tone electron beam (E-Beam) resist. We found that S_Enhancer (300HX02, SHOWA DENKO) application on HSQ has a role to enhance and to maintain its sensitivity during an E-Beam pattern writing[1]. In our investigation, we found another advantage of S_Enhacer application for E-Beam lithography on HSQ at overlay writing. Exposed and developed HSQ pattern shows a convex structure, and when E-Beam scans across this pattern, back-scattered electrons come through the wall of this structure. E-Beam lithography system detects these electrons and determines the mark position. However, HSQ pattern fabricated by E-Beam exposure is affected by E-Beam irradiation. Figure 1 and Figure 2 show the HSQ overlay writing results using the alignment marks made of exposed HSQ pattern. All overlay writings were done using the JBX-9300FS. Damaged alignment mark during the mark alignment process causes uncertain factors and leads to mismatch at overlay writing. As shown in Figure 1 and Figure 2, the overlay writing results are instable when HSQ alignment marks are used.

On the other hand, S_Enhancer-applied HSQ mark pattern exposure yields higher resistance against E-Beam irradiation. Figure 3 and Figure 4 show the HSQ overlay writing results with S_Enhancer application at HSQ mark pattern and L-shaped pattern exposures.

Adding to the sensitivity enhancement, S_Enhancer application compensates uncertain factors and improves overlay accuracy.

Through these experiments, we have confirmed that S_Enahncer-applied HSQ pattern exposure act as the alignment mark fabrication and S_Enhncer-applied pattern exposure on HSQ improve the reliability for overlay writing.

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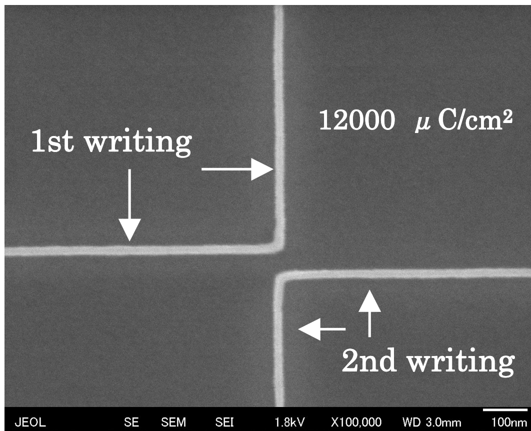
[1] PCT/JP2009/064574



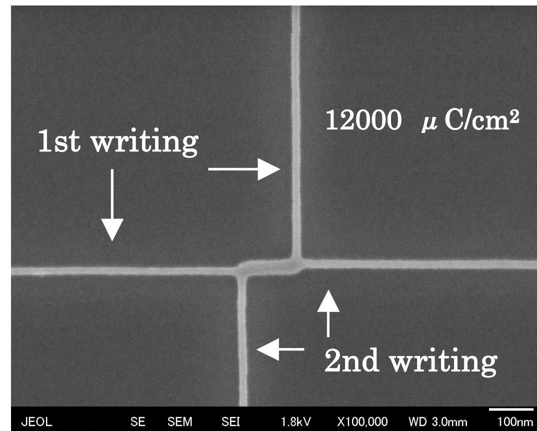
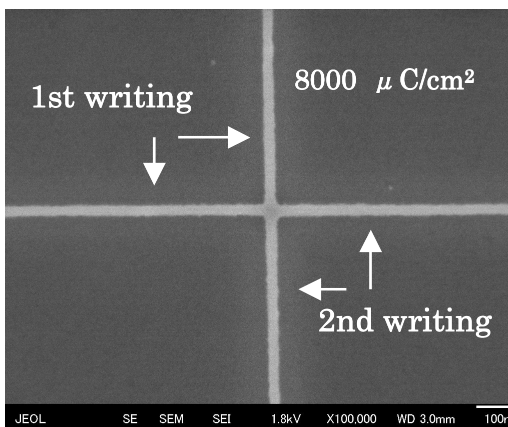


Figure 1 Overlay writing mismatch is (6 nm, 52 nm). Alignment marks were fabricated by HSQ exposure without S_Enhancer application and S_Enhancer was not applied at overlay writing.

Figure 2 Overlay writing repeatability test. Overlay mismatch is (123 nm, 13 nm). Alignment marks were fabricated by HSQ exposure without S_Enhancer application and S_Enhancer was not applied at overlay writing.



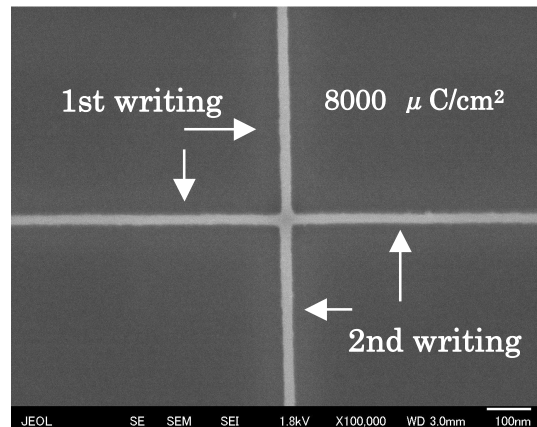


Figure 3 Overlay writing mismatch is (7 nm, 5 nm). Alignment marks were fabricated by S_Enhancer-applied HSQ exposure and S_Enhancer was also applied at overlay writing.

Figure 4 Overlay writing repeatability test. Overlay mismatch is (7 nm, 6 nm). Alignment marks were fabricated by S_Enhancer-applied HSQ exposure and S_Enhancer was also applied at overlay writing.