

Alternative developer solutions for EUV resist

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At present, extreme ultraviolet (EUV) resist sensitivity and resolution limits continue to be improved but line width roughness (LWR) remains an issue.¹ In this paper, to provide possible solutions for LWR improvement, the use of alternative developer solutions is presented.

The use of the tetraethylammonium hydroxide (TEAH) and tetrabutylammonium hydroxide (TBAH) developer solutions are proposed as an alternative to the tetramethylammonium hydroxide (TMAH) aqueous developer solution (semiconductor industry standard). A polyhydroxystyrene-based EUV resist (polymer resist) was utilized at a film thickness of 60nm. To confirm the effectiveness of these alternative developer solutions in improving LWR performance, patterning exposures were carried out using the small field exposure tool (SFET) with annular ($\sigma_{\text{outer}} 0.7/\sigma_{\text{inner}} 0.3$) illumination conditions.

Figure 1 shows the dissolution contrast curves of the polymer resist using the TMAH, TEAH and TBAH developer solutions. Similar dissolution characteristics were observed which means that the use of these alternative developer solutions might have minimal effect on the resist resolution limit and sensitivity. Figure 2 shows the imaging performance using the three types of developer solutions. Resolution limits were maintained at 26 nm 1:1 lines and spaces (L/S). A small variation in the resist sensitivity of 10.0 to 12.4 mJ·cm⁻² was also observed. Figure 3 shows the LWR of the 45 and 32 nm 1:1 L/S patterns with the three types of developer solution. A significant improvement in LWR was observed with the use of the TBAH developer solution (6.6nm at 32nm 1:1 L/S) comparing with standard TMAH (9.3nm at 32nm 1:1 L/S).

During the conference, a detailed analysis of the results with the application of these alternative solutions will be presented.

¹ T. Itani, K. Kaneyama, T. Kozawa, and S. Tagawa, *J. Vac. Sci. Technol. B*26 (6), (2008) 2261-2264.

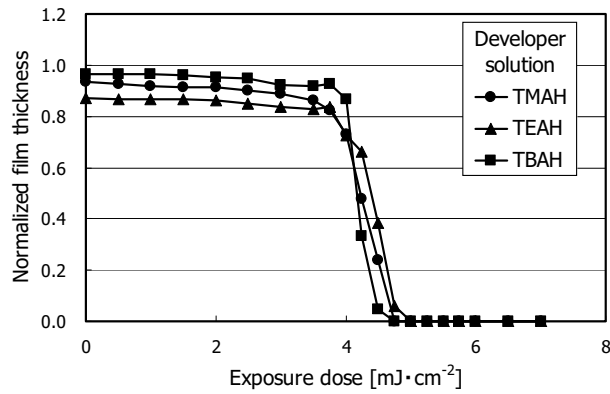


Figure 1. Dissolution contrast curves of the polymer resist using the TMAH, TEAH and TBAH developer solutions.

		Pattern size (1:1 L/S)				
		35nm	32nm	30nm	28nm	26nm
Developer solution	TMAH		Esize= 11.2mJ·cm ²			
	TEAH		Esize= 10.0mJ·cm ²			
	TBAH		Esize= 12.4mJ·cm ²			

Figure 2. Imaging performance with the TMAH, TEAH and TBAH developer solutions using the SFET.

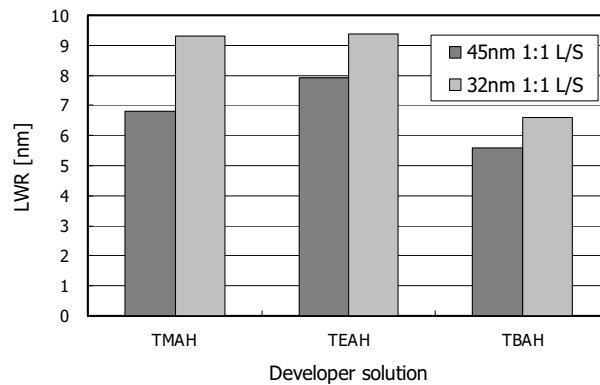


Figure 3. LWR of the 45 and 32 nm 1:1 L/S patterns with the TMAH, TEAH and TBAH developer solutions.