Absorber stack with transparent conductive compound material for EUV lithography mask

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Recently, various extreme ultraviolet lithography (EUVL) masks have been studied as a tool for patterning semiconductor devices beyond the 32-nm node. The EUVL mask consists of high reflecting stacks and absorbing stacks. The absorber stack in the EUVL mask began to drag more attentions since it is directly related to pattern fidelity, mask yield, defect inspection efficiency, and defect correction process[1]. The optical constant of the absorber stack in the EUV region should have higher extinction coefficient for higher attenuation and the top of that should exhibit good conductivity, which can alleviate the charging affect during electron-beam patterning.

It is reported that TaN and Al_2O_3 layers are used as the attenuator and ARC layer in the absorber stack[2], respectively, and the total thickness of the absorber stack is greater than 80 nm. The thick absorber stack causes a shadow effect in the exposure step and as a result, the printed patterns are shifted and biased[3].

In this study, we propose new absorber stacks with various transparent conductive compound layers. The optical constants of ITO layers with various concentration of Ag at 13.5 nm are calculated. It is found that ITO layers with high concentration of Ag show lower refractive index and higher extinction coefficient at 13.5 nm than those of TaN layer. Hence the ITO layers enable to design the absorber stack with minimal thickness and reduce the geometrical shadow effect. Further, attenuated phase shift masks with the ITO layers are designed to have very small height difference between high reflecting and absorbing stacks, indicating that the geometric shadow effect can be significantly reduced.

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[1] S. Hector, and P. Mangat, J. Vac. Sci. Technol. B **19**, 2612, (2001)
[2] S. Y. Lee, T. G. Kim, C. Y. Kim, I.-Y. Kang, Y.-C. Chung, and J. Ahn, Proc. SPIE **6151**, 61511Y (2006)
[3] M. Sugawara, A. Chiba, and I. Nishiyama, J. Vac. Sci. Technol. B **21**, 2701 (2003)