Transparent and conductive backside coating of EUV lithography masks for Ultra short pulse laser correction

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Photolithographic masks especially for extreme ultraviolet lithography (EUVL) have to fulfill demanding requirements with respect to critical dimension (CD) uniformity, mask flatness, and especially image placement (registration) as well as mask-to-mask overlay. These challenges require highly precise techniques for the production of extreme ultraviolet (EUV) masks. It is already known that an optical photomask can be modified in a controlled manner in order to correct image placement signatures by applying ultra-short laser pulses into the substrate by using the RegC system. This compensation occurs through multiphoton absorption of incident light from the backside of the mask. Applying this technology to EUV masks thus requires a backside coating sufficiently transparent at the wavelength of the ultra-short laser pulses.

On the other hand, an extremely careful handling and chucking of EUV mask is necessary in order to avoid as much as possible mechanical abrasion and the formation of particles, which may deteriorate the function of an EUV lithography system. In order to fulfill these handling requirements, EUV mask are held through an electrostatic chuck in the scanner. As the substrate of EUV masks is a dielectric, usually glass, or a semiconducting material, an electrically conducting layer has to be deposited on the backside in order to be able to hold the substrate with an electrostatic chuck. Therefore, in order to allow image placement correction by ultra-short pulse laser technology, the rear side coating has to be optically transparent and electrically conductive at the same time.

Ultrathin metals, their nitrides and oxides, borides, carbides or combinations, if sufficiently thin become transparent while still being electrically conductive. We will present results on backside coatings for lithography masks, especially for EUV applications, consisting of multilayer films made of ultrathin Cr, Cr nitrides and oxides having different compositions and thicknesses. Different compositions are obtained by varying the atmosphere during deposition. For example, during deposition of the Cr atoms on a substrate one can obtain different CrN_y compositions by a proper ratio of N_2 and Ar during the sputtering process. Though we show results on Ni and Cr, the concept can be extended to any other suitable metals and combinations of nitrides, oxides, borides, and carbides of proper stoichiometry.

In the talk we will present our studies that confirm the possibility to achieve an optically transparent (transmission of 20-50%) and electrically conductive (sheet resistance of 50-200 ohm/sq.) backside coating for lithography masks with high mechanical resistance and durability, the latter attributes being tested also through abrasion, adhesion and scratching tests. We will also demonstrate pixel writing through such coating, enabling the technological path to correction and tuning of image placement on EUV masks.