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Optimization of plasma assisted reactive sputter deposition processes for optical coatings

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In order to meet the challenging requirements of optical coatings for modern applications, advanced methods of process optimization and state of the art deposition tools must be used. Besides other thin film coating technologies such as evaporation and PECVD sources, the Evatec AG develops innovative reactive sputter deposition sources. These sources are often combined with plasma sources for an additional plasma treatment of the growing film, altering the film properties. Here, the effect of an additional capacitively coupled radio frequency plasma on both the deposition process and the resulting thin film is presented. The sputter plasma and the plasma source are active at the same time in the same vacuum environment, allowing for an effective interaction. Hence, the substrates, which are loaded on a rotating turn table, are repeatedly exposed to both the sputter source and the plasma source. Depending on the conditions, the additional treatment by the plasma source may affect the deposition process physically by the energetic ions generated as a significant part of the quasi-neutral plasma beam, that bombards the surface, and chemically by generating reactive species such as atomic oxygen. A significant interaction is observed between the auxiliary rf plasma and the dc pulsed sputter plasma, where an active process control of the reactive gas flow is utilized to optimize the overall sputter conditions as well as the process rate. The plasma source and its interaction with the sputter source are characterized utilizing various diagnostic approaches, such as voltage and ion energy measurements as well as optical emission spectroscopy. Finally, the benefits in the properties of thin films grown in such processes with additional plasma treatment are highlighted. It is demonstrated, that optical single- as well as multi-layer systems of silicon dioxide and amorphous hydrogenated silicon with excellent uniformity at very low levels of stress, roughness, and absorption in a reproducible way.

Keywords
reactive sputtering
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