Fabrication of nanogradient optical coatings by magnetron sputtering

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Nowadays, much attention is paid on coatings with refractive index $n$ distributed with nanometer variation within coatings. They are called as nanogradient coatings. The challenge is to develop a fabrication method, which could provide the desired thickness profile of $n$. Analysis of different approaches shows that the most appropriate is middle frequency pulse (MFP) magnetron discharge co-sputtering of several materials in a reactive gas atmosphere of constant composition at constant sputtering power of each component. The MFP technology is chosen because it provides the stable precisely controlled operation of magnetrons. The automated two-magnetrons installation for sputtering two materials (e.g. Si and Ti) has been developed. During deposition the location of several substrates varies in a plane above the magnetrons in accordance with the coating program. Each substrate rotates around its own axis and revolves around a common axis for all substrates, and the coordinate of the common axis is changed accordingly to the program. Two sputtered atom flows are mixed above the magnetrons and there is some distribution of the mixed atom flow composition on the substrate plane. The substrates intercept the atoms sputtered from both the magnetron targets, and thus, the instantaneous (current) composition of the deposited matter depends on the common axis coordinate. The duration of each common axis position is defined by the program, then we obtain the desired profile of $n$. The programs are able to provide different profiles of $n$ (e.g. $n$ varies from $n(\text{SiO}_2)$ to $n(\text{TiO}_2)$ with sine wave modulation) for fabrication of subwavelength photonic barriers, hyperwide antireflection coatings, phase correctors, filters and polarizers, gradient metacoatings [1] with excellent characteristics. [1] O.D. Volpian, A.I. Kuzmichev, Negative wave refraction. Introduction to physics and technology of electromagnetic metamaterials. Kiev, 2012.

Keywords
nanogradient optical coatings
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