Computer controlling of writing beam in laser microfabrication of diffractive optics

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Abstract

Laser microfabrication of diffractive optics with continuous relief is based on the direct local action of focused laser radiation on the recording material. Control of writing beam parameters (beam power, spot size, waist position) is one of the main tasks in microfabrication using laser writing systems. Method of the control defines the correspondence between the fabricated microrelief of the diffractive optical element and a designed one. Complexity of this task consists in the necessity to take into account a wide range of factors: laser irradiation noises, non-linear characteristic curve of recording material, finiteness of spot size, influence of power modulation and surrounding on beam energy absorption, influence of beam waist position according to recording layer, dependence of characteristic curve of recording material on beam scanning speed, etc. In the present paper we consider a number of methods for computer controlling of writing beam making it possible to compensate or reduce the influence of these factors and improve the quality of DOE microfabrication. The results of experimental application of the developed methods to circular laser writing systems are discussed.

Keywords: diffractive optics, microfabrication, direct laser writing, circular laser writing system.

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References

[1] Soifer VA, ed. Methods of computer optics [In Russian]. Moscow: “Fizmatlit” Publisher; 2000.
[2] Herzig HP, ed. Micro-optics: Elements. Systems & applications. London: Taylor & Francis; 1996.
[3] Turunen J, Wyrowski F, eds. Diffractive optics for industrial and commercial applications. Berlin: Akademie Verlag; 1997.
[4] Koronkevich VP, Kiryanov VP, Korol'kov VP, Poleshchuk AG, Cherkashin VV, Kharisov AA. Fabrication of diffractive optical elements by laser writing with circular scanning. Proc SPIE 1995; 2363: 290-297.
[5] Gale MT, Rossi M, Pedersen J, Schutz H. Fabrication of continuous-relief microoptical elements by direct laser writing in photoresists. Opt Eng 1994; 33: 3556-3566.
[6] Wu C. High energy beam colored glasses exhibiting insensitivity to actinic radiation. U.S. Patent 4567104 of January 28, 1986.
[7] Gotchiyaev VZ, Korolkov VP, Sokolov AP, Chernukhin VP. High resolution optical recording on a-Si films. Journal of Non-Crystalline Solids 1991; 137-138: 1297-1300.
[8] Kiryanov VP, Kokarev SA. Subnanometer-resolution laser interferometric displacement sensors. Optoelectronics, Instrumentation and Data Processing 1998; 2: 3-7.
[9] Korolkov V, Shimansky R, Poleshchuk A, Cherkashin V, Kharissov A, Denk D. Requirements and approaches to adapting laser writers for fabrication of gray-scale masks. Proc SPIE 2001; 4440: 256-267.
[10] RaiChoudhury P, ed. Handbook of microlithography, micromachining, and microfabrication: Microlithography. Bellingham, Washington, USA: SPIE Optical Engineering Press; 1997.
[11] Poleshchuk AG, Korolkov VP, Cherkashin VV, Reichelt S, Burge JH. Polar-coordinate laser writing systems: error analysis of fabricated DOEs. Proc SPIE 2001; 4440: 161-172.