Coherent Diffraction Optics for VUV and X-Rays.

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In classical optics, the original sense of the word coherence was attributed to the ability of radiation to produce interference pattern. In quantum optics the notion of coherence is defined more generally by the correlation properties between quantities of an electromagnetic field. Moreover, coherence following to quantum optics can be described in a form of a wave and therefore treated as a wave function. A manipulation with coherence by diffraction optical elements is widely used in different physical experiments and instrumentation. In this sense we should speak not only about coherence preservation but also coherence transformation phenomena. Usual interference is the simplest phenomenon revealing correlations between complex amplitudes of light waves. The general holographic concept based on interference wave amplitude theory can be also successfully applied to x-ray diffraction optics design in a form of synthetic (artificial) hologram formalism. When coherent (laser) light strikes some optical element: semi-transparent body or some surface in space, a constructive interference used for image transfer or light focusing is accompanied by random statistical multiple beam interference. In addition to an expected image a speckle pattern is observed. The speckle phenomenon is brought about by statistically distributed field amplitude. The constructive and destructive influence of speckle on different performances of diffractive optics is the subject of discussion in this talk. The technological requirements for the fabrication of the diffraction optics for coherent radiation taking into account a speckle effect are analysed. As practical examples of holographic designed X-ray-VUV optics Bragg-Fresnel lenses on multilayer and crystal substrates as well as reflection zone plates on a super-polished mirror surfaces are shown. The ability of modern optical tests instrumentation for surface control in nanometre range is demonstrated.