

Frequency domain analysis of surface errors based on imaging performance

Shan Wu¹, Jinshi Wang^{1,#}, and Fengzhou Fang^{1,#}

¹ State Key Laboratory of Precision Measurement Technology & Instruments, Laboratory of MicroNano Manufacturing Technology—MNMT, Tianjin University, 300072, China

Corresponding Author / Email: jswang@tju.edu.cn, fzfang@tju.edu.cn

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The surface errors introduced during the manufacturing process can be categorized into low, mid, and high spatial frequency regions of the power spectral density function. These three regions have different effects on image quality, such as the diffraction-limited point spread function (PSF). Generally, low spatial frequency errors cause conventional aberrations, mid-spatial errors result in small-angle scatter, and high spatial frequency errors lead to wide-angle scatter. However, the cutoff frequencies of the three regions are unclear and largely depend on design and manufacturing experience. This paper establishes a surface error model for a three-lens system using sinusoids, which typifies the structural errors in ultra-precision diamond turning. The relationships between cutoff frequencies and diffraction PSFs are systematically studied, which are also related to wavelength, stop position, field of view, and the distance between the surface with errors and the image plane.
