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Tesis: "SURFACE MEASUREMENT WITH VERTICAL SUPER-RESOLUTION OF ALUMINUM THIN FILMS BY USING PHASE-SHIFTING INTERFEROMETRY"

Resumen:

In this dissertation, we present a procedure to measure the phase from non-uniform phase-shifting interferograms in order to estimate the surface topography of an aluminum thin film. Interferograms are acquired from a Michelson interferential microscope, and phase shifts among interferograms are non-uniform because a piezoelectric transducer (PZT), working in open-loop mode, is used as phase shifter. Non-uniform phase shifts generate two types of errors in phase measurements: the double-frequency ripple distortion and the spurious piston. Thus, in order to overcome the aforementioned errors, we design error-correcting and non-iterative phase shifting algorithms (PSAs). For this purpose, considering that non-uniform phase shifts can be expressed as a polynomial function of the unperturbed phase shift ($\omega 0$) and using the frequency transfer function (FTF) formalism, we show that the conditions to overcome errors in phase measurements are associated with m-th derivative of the PSA's FTF. Hence, we deduce two new conditions: 1) the m-th derivative of the FTF evaluated at $\omega = -\omega 0$ to suppress the double-frequency ripple distortion, and 2) the m-th derivative of the FTF evaluated at $\omega = \omega 0$ to eliminate the spurious piston. Then, taking into account the m-th derivative of the FTF evaluated at $\omega = -\omega 0$, we design a nine-frame PSA in order to estimate the surface topography of an aluminum thin film. This result is free of ripple distortions and it is better than those obtained using the Fourier transform method, the least-squares PSA, and the principal component analysis method. Finally, we applied our nine-frame PSA to three different sets of non-uniform phase-shifting interferograms. Demodulated phases are summed in order to obtain a phase with vertical super-resolution (Vertical sensitivity), equivalent to measure surfaces with a synthetic ultraviolet wavelength. Computer simulations and experimental results prove us right.