INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	Nagendra Kumar
Roll Number	:	156121024
Programme of Study	:	Ph.D.

Thesis Development of grating array based zonal wavefront sensor for in-situ surface profiling during the growth of the thin film in a deposition system

Name of Thesis Supervisor(s)	:	Prof. Bosanta R Boruah and Prof. Alika Khare
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SHORT ABSTRACT

In this thesis, a novel grating array based wavefront sensing (GAWS) scheme is proposed and demonstrated experimentally which can be used to measure both the thickness and surface profiles of the thin films simultaneously as a function of time during the growth process of the film. This scheme does not require any prior information on the properties of the substrate and target material, provided both the substrate and film are reflecting. We use a grating array based wavefront sensor (GAWS) assembly, realised with a ferroelectric liquid crystal spatial light modulator, integrated to a pulsed laser deposition system in order to measure the thickness and surface profiles, simultaneously, of Cu thin films on a well-polished stainless-steel substrate, during deposition as a function of time. An appropriate algorithm is developed to obtain the thickness and surface profiles from the measured phase profiles of the GAWS. The post deposited thickness profile obtained from the GAWS is found to be in reasonable agreement with that of a commercial profilometer. Further, two novel schemes to enhance the sensitivity and dynamic range of the wavefront sensor are also proposed and demonstrated experimentally. We verify the accuracy of the scheme to enhance sensitivity by measuring known amount of holographically introduced aberrations. The scheme to enhance the dynamic range is tested on the transmitted wavefronts through convex and concave lenses. The radii of curvature of the transmitted spherical wavefronts measured by the proposed zonal wavefront sensing scheme and the corresponding estimated focal lengths of the lenses show agreement with the commercial data provided by the lens manufacturer. The detection path of the integrated system can be easily rearranged to activate the high sensitivity as well as the high dynamic range mode of the scheme to carry out in-situ measurements. With enhanced sensitivity, the integrated system can be implemented to monitor highly uniform thin films in-situ during deposition while with enhanced dynamic range it can assess the deposition of periodic and non-periodic curved as well as plane structures.