**1. Introduction**

Surface roughness measurement is crucial in several applications, including high-quality optics, production of optical diffusers, thin film components, solar cells, data storage on surfaces and surface quality control [1–5]. Several methods are available for measuring the surface roughness. Stylus profilometry(SP) [6] and scanning probe microscopy (SPM) can provide the surface morphology, directly. Optical methods including optical profilometry [7, 8], interferometry [9–11], speckle interferometry [12, 13], and light scattering [14–20] have been used, as non-contact methods, for roughness measurement. The methods based on light scattering do have relevant advantages such as the nondestructive methodology, large sampling size, and the capability to provide real-time measurements [21, 22].

In most of the works done on light scattering from rough interfaces, the measurement of the coherently or diffusely scattered light intensity, in far field approximation, leads to determination of the surface roughness [23–32]. However, in principle, measurement of these parameters is not straightforward.

In our previous report [33], based on Fresnel diffraction theory, the transmitted light scattering from a randomly roughed interface is studied by projecting a periodic light intensity distribution on the interface. We showed that the scattered light intensity in Fresnel regime depends on statistical properties of the rough interface and the light intensity period. The dependence of the self-images contrast, on the interface height-height correlation function in terms of multiplication of the self-image number and the period of the light intensity distribution is exponential. We applied the approach to determine the roughness of the interfaces by several square gratings with periods much longer than the correlation lengths. The samples were prepared by roughening the sheet glasses by powders of different greet numbers. The results by different gratings with different light wavelengths, were quite consistent. Since this method is based on determination of the contrast, the results is more applicable and accurate than those from intensity measurements. Moreover it doesn’t need a smooth reference sample. However, the problems in transmission mode are that the roughness can be only determined for transparent materials and the refractive index of the sample must be known. These are avoidable in reflection measurements.

In reflection methode the theoretical considerations reveal that the optical path difference, due to the height distribution, can be changed simply by varying the incident angle, thus low roughness can be measured more accurate at small incident angles. Moreover, increasing the incident angle provides the possibility of measuring higher roughness. An additional great consequence can be achieved by using both reflection and transmission methods. The consequence is specifying the refractive index of the samples that have rough interface such as thin films. This paper is organized as follows: In Section 2, we introduce the theoretical approaches and calculate the near-field scattered light intensity in reflection from a rough surface using a square grating. We show that, at Talbot distances of the grating, the surface height difference function can be defined as magnitude response of scattering to different spatial frequencies.

When the argument of the height difference function is larger than twice the surface correlation lengths, the contrast measurements provide the surface roughness. Also, we determine the refractive index in terms of the contrasts in both reflection and transmission methods. The experimental results are presented in section 3. Conclusions of the work are outlined in Section 4.