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NON-DESTRUCTIVE MEASUREMENT TECNIQUE BY USING SPECKLE PHOTOGRAPHY

Ali Güngör
The University of Bahçeşehir, The Faculty of Engineering
Beşiktaş, İstanbul
TURKEY
e-mail: aligun@bahcesehir.edu.tr

ABSTRACT
Electronic speckle photography [1, 2, and 3] offers a simple and fast technique for measuring any change on the surfaces without any destruction on the surfaces. The investigation of the random intensity distribution, called speckle pattern, in the scattered light in the far-field region from metal and polymer films give very important information about structure and surface profile of the films.
Keywords: laser speckle, electronic speckle photography,

1. INTRODUCTION
A coherent laser light reflected from a diffusive surface produces laser speckle. That is, the reflected light appears to be made up of bright and dark spots or speckle as seen in the figure 1. This is due to the the coherent light reflected from small peaks and valleys on the diffusive surface and interfering on the detector.

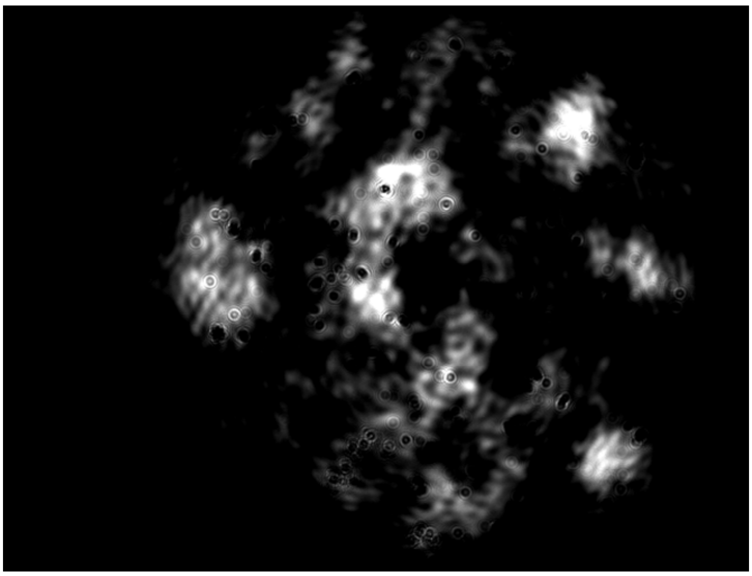

Figure 1. Speckle pattern formation from a water layer

Modern speckle photography based on the computer aided data collection and evaluation speckle patterns.

The image of a typical pattern on the object is recorded with charge - coupled devices (CCD) [4] camera and images are stored on the computer.

2. EXPERIMENTAL METHOD

Our experimental arrangement is shown schematically in the figure 2. A 5 mW He-Ne gas laser of wavelength $\lambda = 632.8\,nm$ is used as a coherent light source. Laser beam is expanded by a beam expander lens system (L) and directed onto the system (S) which will be examined. The speckle patterns are obtained by backscattered light from thin gold and non-linear polymer films in the far field region. The intensity distribution varies randomly in time and space. The intensity variation is detected by a CCD camera and stored on the computer.

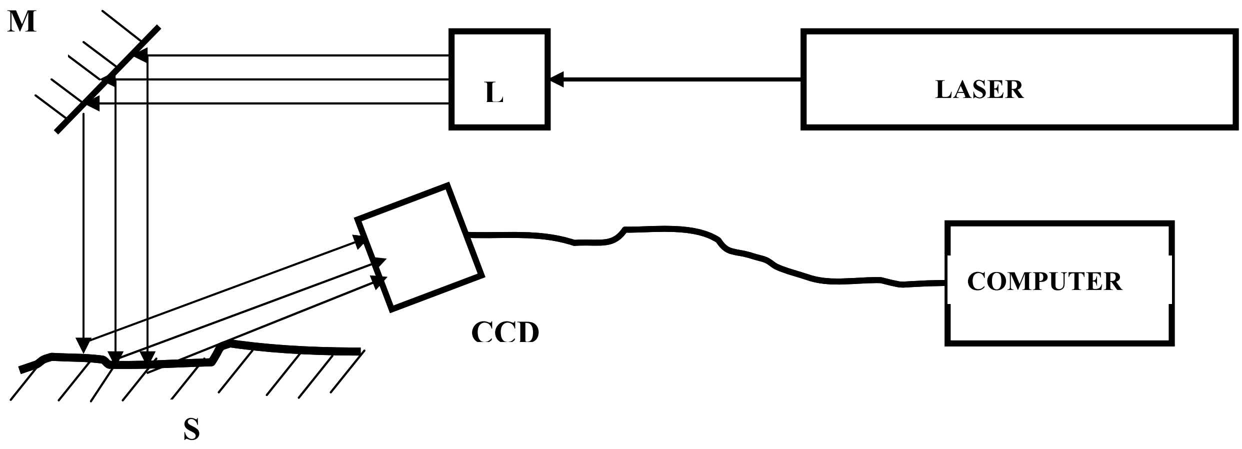

Figure 2. The experimental setup for Speckle Photography

The data collected for gold and non-linear polymer films is used to analyze the intensity variations of the speckles patterns for specific pixel of the CDD camera. The Fourier Transform (FFT) of the samples shows some differences in intensity and structures of the pixels.

3. RESULTS AND DISCUSSION

The data taken by the CCD camera and stored on the computer is analyzed by selecting specific pixels. The intensity variation of the specific pixels in time, incident laser power and chopping frequency dependence is analyzed for gold and polymer coated gold films.

The intensity variation of the speckles which are created by polymer gold film and gold film shows similar behaviors. A typical intensity variation of the speckles for specific pixel in time is shown in the figure 3 for different incident He-Ne laser power. The intensity of the speckles is almost constant in time .Only laser power fluctuation is more prominent in the low power He-Ne laser incident. This result shows that if we obtain some fluctuation changes in the light speckles from a surface that means there is a physical changes on the surface and this is a good testing without any destruction on the surface.

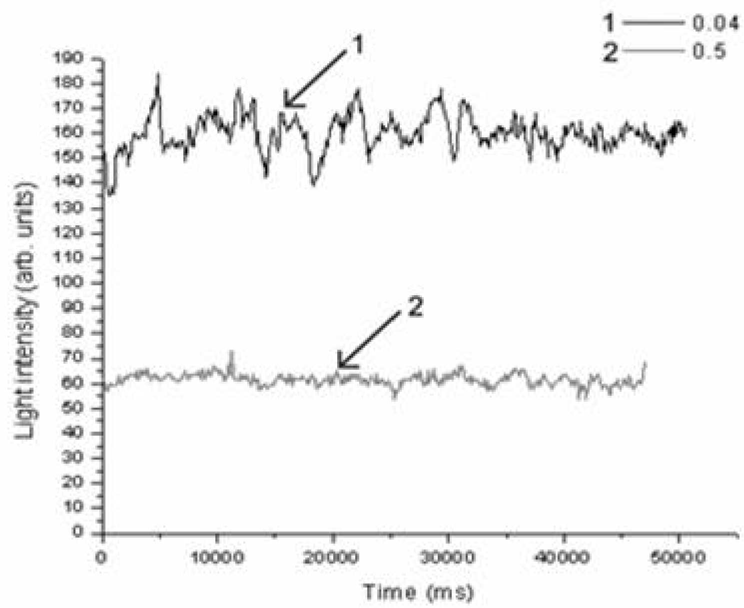

Figure 3. The change of speckle pattern intensity in time for different incident laser power

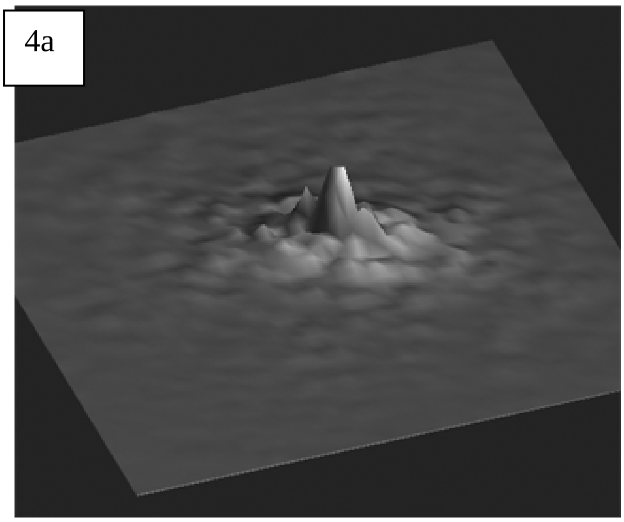

Figure 4a. Spatial FFT transform of th e ploymer- coated gold film

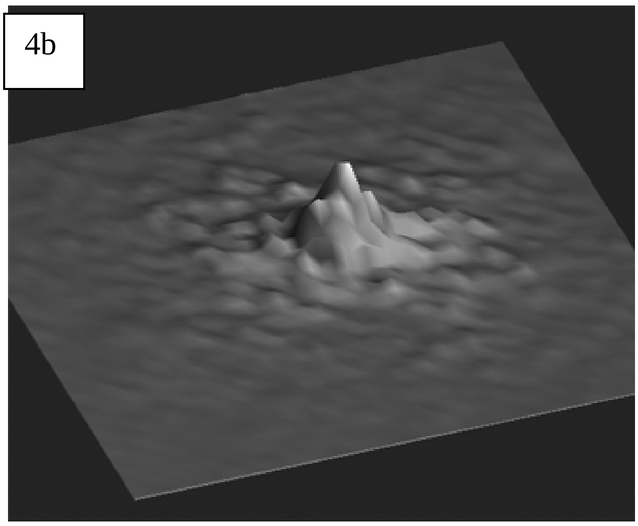

Figure 4b.Spatial FFT transform of the ploymer-coated gold film.

We have studied the Fast Fourier Transformation (FFT) for gold and polymer-coated gold surfaces. As we can see from Figure 4 there is a structural change on the speckle response of the different film surfaces. This technique can be used to detect the structural changes on the surface of thin films.

The dependence of the Fourier spectrum of the speckle signal for paper, polymer-coated gold surface and gold surface are shown in the Figure 5. As seen from figures, the chopping frequency dependence for paper, gold film and polymer-coated gold film speckle patterns are similar. There no laser power dependence for paper speckle patterns

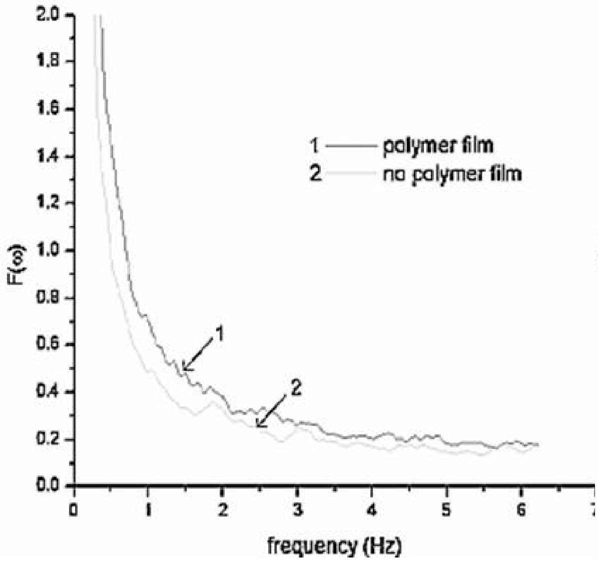

Figure 5a. The Fourier spectrum of the speckle patterns for polymer-coated gold film and gold film

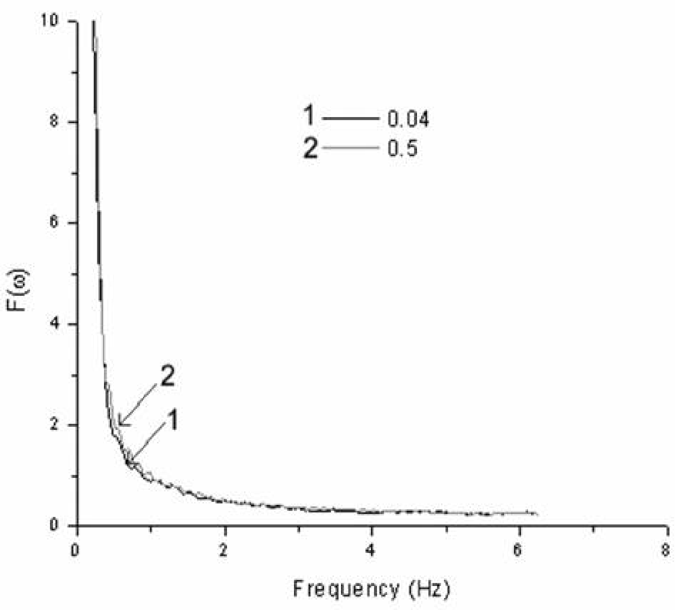

Figure 5b. Paper sample: No laser power dependence in Fourier spectrum

4. REFERENCES

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[4] See web page for the optics companies as Nicon, Konica, Minolta, Canon, etc