REFLECTION HOLOGRAM FOR PARTICLE SIZE MEASUREMENT

A. AL-AITHAWI and J. KORNIS

Institute of Physics
Technical University, H-1521 Budapest
Received May 10, 1989

Abstract

Reflection hologram was used to record the transparent dynamic particle. By this method there is high protection to the optical devices. Another information about particle size and particle distribution has been obtained. The major limitation of in-line Fraunhofer hologram has been solved.

Introduction

Fraunhofer holography is very important method used in field of particle size analysis. From the first application in this field [1], until now all methods used transmission hologram, some of them used the forward scattered or back scattered light to record the hologram [2].

Thompson [3], reported that the major limitation of the in-line Fraunhofer hologram is, that it is used only with transmitted light, it can not truly be used in reflected or back scattered light.

To record Fraunhofer hologram, the sample volume must satisfy the condition $Z \gg d^2/\lambda$, where Z is the distance from the test volume to the hologram plate, d is the particle diameter and λ is the wave length of the laser beam. By recording the reflection hologram, all the a fore mentioned problem may be solved.

As we know the reflection hologram occurse when the angle between the object and the reference beams is 180° [4].

Experiment

(1) Recording

In our arrangement as shown in Figure 1, the object beam is the reflected light, and in the opposit direction with the reference beam on the hologram plate. So the hologram is a reflection hologram.

The sample volume *S* was illuminated by laser light through the beam expander *BE*. Usually the transparent object scattered the light in all

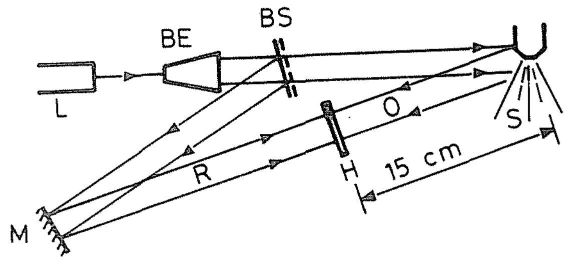

Fig. 1. Recording system; *L* is a ruby laser, *BE* beam expander, *M* plane mirror, *H* hologram plate, and *S* is a spray particles

directions, we chosed the back scattered light at the angle 11°, for two reasons: first a separated reference beam can be used to solve the problems of the Fraunhofer condition and the coherence length in in-line reflection hologram arrangement, second the arrangement with this angle will need a small table and a few optical devices.

The collimated beam was split by using a beam spliter to get a reference beam. The splitting beam was reflected by *M* and incident on the hologram plate (AGFA GEVAERT 8E75). *M* can be moved to make the angle RHO = 180°. The distance between *S* and *H* = 15 cm, which satisfies the Fraunhofer condition. The ruby laser *L* has been developed at the Department of Physics, Technical University Budapest. At the measurement the pulse energy was 300 mJ, and the duration of the pulse was 20 ns. A He—Ne laser not shown in the figure was used for the alignment. The pressure of the water studied in our experiment coming through a (H 1/4 vv ss 1508) nozzle was 1 bar.

The hologram plate was developed by a chemical solution (Methanol U) for 4 min, and was fixed for 5 min.

(2) Reconstruction and Evaluation

The reconstruction system is shown in Figure 2. A He—Ne laser 20 mw with 2 mm beam diameter is illuminating the developed hologram. In front of the plate *H* the TV camera was placed and connected with closed TV circuit. IBM compatible computer was used to analyze the hologram, and the reconstructed real image is shown in Figure 3.

The program developed at the Technical University Budapest was used to calculate the size of the particle. The evaluation of the hologram is based on counting the number of the TV pixel in the reconstructed real image, and this represent the area (*A*) of the particle.

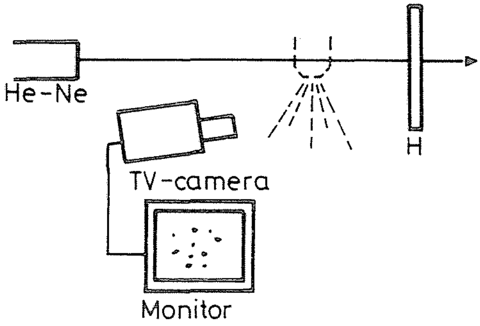

Fig. 2. Reconstructed system

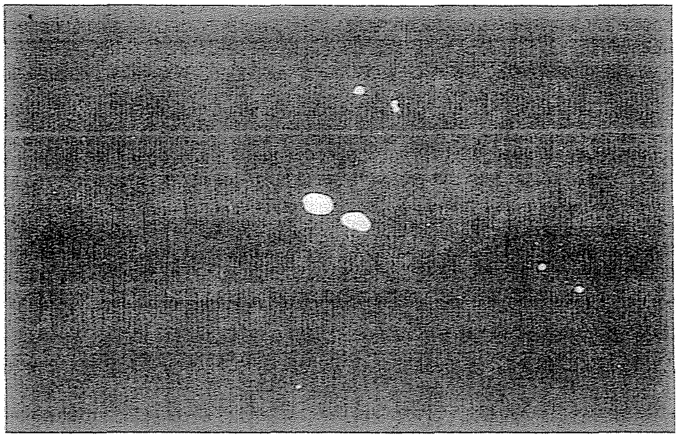

Fig. 3. A reconstructed real image

For spherical particle:

$$A = r^2 \pi \tag{1}$$

where r is the radius of the particle.

From relation (1) the diameter of the particle can be measured ($d = 2r$).

The result of the measurement is shown in Table 1, the average particle size is 131.3 μm.

Table 1

Particle size μm	Particle distribution %	Particle size μm	Particle distribution %
22	22.06	182	0.69
32	9.65	184	2.07
40	11.03	188	1.38
46	4.82	190	0.69
50	4.82	194	1.38
56	1.38	200	0.69
60	3.45	220	1.38
64	0.69	240	0.69
68	1.38	280	0.69
72	2.07	380	0.69
74	0.69		
78	1.38		
88	0.69	Average size = 131.3 μm	
90	0.69		
94	0.69		
96	0.69		
98	1.38		
104	0.69		
106	2.07		
110	1.38		
112	3.45		
128	0.69		
130	0.69		
132	0.69		
134	0.69		
136	0.69		
138	0.69		
140	0.69		
142	1.38		
154	2.07		
162	2.07		
166	0.69		
170	0.69		
178	2.07		
180	0.69		

Conclusion

From this experiment it has been found that the refelction hologram is a very useful method in case of particle sizing because: (1) Information about the size of particle was obtained in case of reflection light. (2) By using a lens to image the object in recording stage, it is possible to used a sun light or a projector light to reconstruct the hologram. (3) Hologram with high differention efficiency can be obtained.

Acknowledgement

The authors would like to acknowledge Dr. Füzessy Zoltán, the director of postgraduate studies for his advices.

References

1. THOMPSON, B. J.: J. Appl. phys. *4* (1965) 302.
2. MATTHEWS, B. J.: 1971 proc. semin. Development in Holography ed THOMPSON, B. J. and DEVELS, J. B. (Redondo Beach, California: SPIE 25, 157—68.
3. THOMPSON, B. J.: A symposium sponsored by ASTM committee E-29 on particle size measurement Kansas city, Mo, 23—24 June 1983, 111.
4. COLLIER, R. J.: (1971) Optical Holography, Academic Press New York, San Francisco, London P 253.

AL-AITHAWI Adnan Saleh (IRAQ) H-1521, Hungary
János KORNIS H-1521, Hungary