Laser speckle as a useful phenomenon

Laser Speckle and Applications in Optics

M. Françon
172 pp. Academic, New York, 1979 (French ed., Masson, Paris, 1977). $16.00

Reviewed by J. Christopher Dainty

The random scattering pattern called "speckle" that is frequently seen in laboratories where lasers are used has received considerable attention in the last few years. The subject is hardly new—in 1877, Karl F. J. Exner studied the speckle produced by candle light scattered from a glass plate on which he had breathed—but the intense coherent radiation of the laser has made the phenomenon obvious, indeed almost unavoidable, in laboratory experiments.

Speckle has a Jekyll and Hyde character, being a useful carrier of information to some and a nuisance to others. *Laser Speckle and Applications in Optics* concentrates on the former aspect. It is written by a distinguished teacher and researcher, Maurice Françon of the Institut d'Optique, Paris; the present edition is a translation of the original. The translation itself is rather literal and many phrases (such as "iterated experiments" on page 115) could have been reworded. Of the obvious typographical errors, perhaps the worst is the "Wallaston prism" (instead of Wollaston) which appears ten times on page 126.

Françon has the knack of explaining the principles of even the most complex technique in simple terms, without involving excessive mathematics. At least fifty applications and their variations are clearly described with beautiful diagrams.

Although there are 230 references in the bibliography, only a quarter of them are actually referred to in the text. The author, in general, quotes only the original paper that first suggested the technique he is describing, thus placing the credit where it belongs. However, many readers may wish to know how a particular technique has progressed; little indication of this is given.

Two books on speckle phenomena have been published in the past five years and the content of this volume overlaps both, particularly *Speckle Metrology* edited by R. K. Erf [see following review]. The distinguishing feature of Françon's book lies in its individuality.

This book is full of ideas for applied-optics research projects at all levels from high school to university and industry. *Laser Speckle and Applications in Optics* should be read by everyone interested in the applications of physical optics.

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J. Christopher Dainty, associate professor at the University of Rochester, works in statistical optics and image science.

Deleterious effect of laser speckle, as demonstrated in two images of lettering mounted on a piece of diffusion glass. In the photograph on the left, the lettering was illuminated with incoherent light. The photograph on the right was made using a laser as a source of coherent light.

Speckle Metrology

R. K. Erf, ed.
331 pp. Academic, New York, 1978. $29.50

Laser speckle noise has proved to be a universal nuisance as far as most laser applications are concerned, and it is only recently that investigators have turned from the unwanted aspects of speckle toward the uses of speckle patterns in a wide variety of applications. *Speckle Metrology* is a timely book that describes the application of laser speckle to the solution of practical problems in industry, including such areas as surface roughness evaluation, displacement and strain movement, and vibration and deformation analysis. While the ten chapters, including five sub-chapters, are written by several authors, the amount of repetition is kept to a minimum, and for the most part there is a smooth flow between the different chapters. The book serves well as a complement to the excellent book *Laser Speckle and Related Phenomena*, edited by J. Christopher Dainty.

After an introductory chapter that is basically an outline of the book, a five-page chapter describes the physical properties of speckles. It would have been better if this chapter had been expanded to cover more of the common material that is used in all the following chapters.

One of the best chapters in the book describes five non-contact, non-destructive, methods of using speckle patterns to measure surface roughness properties. With visible light and small angles of incidence, the methods described can be used for measuring fine-scale surface roughness ranging in scale from less than 0.25 microns to more than 30 microns. The range can be expanded by employing other wavelengths and other angles of incidence.

Several chapters discuss speckle techniques for measuring displacements, including deformations, vibrations, and motion paths. Included are chapters describing the inspection of large struc-

tures and the study of transient phenomena. The latter might be of particular interest in laser-fusion studies, where speckle interferometry could be used to study the space-time development of a pellet implosion.

The use of video equipment with speckle metrology is dicusssed in detail. These techniques are of particular interest, because they provide a means of real-time storage, good display, and they make it convenient to process in computers. This is the area where the greatest developments are expected in speckle metrology during the next five to ten years.

Robert Erf has done a good job in putting together a book describing for the most part the "state of the art" of speckle metrology. Both theoretical concepts and experimental techniques for using speckle properties to make measurements are presented. The book is a must for everyone who wants to keep up to date on recent developments in metrology.

JAMES C. WYANT
University of Arizona

Vacuum Physics and Technology

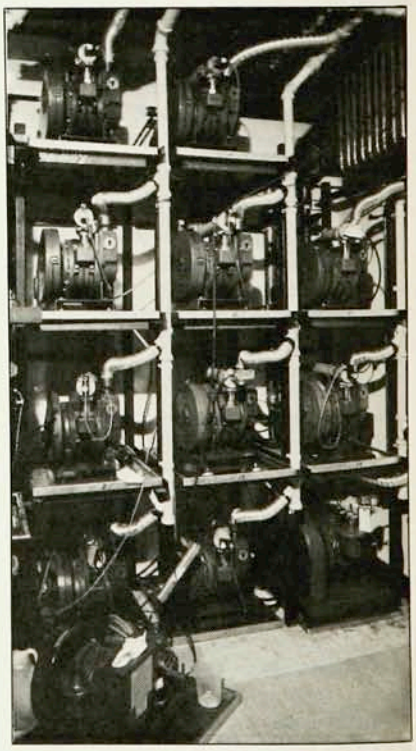
G. L. Weissler, R. W. Carlson, eds.
616 pp. Academic, New York, 1979.
$55.00

Under editors-in-chief L. Marton and C. Marton, the multivolume "Methods of Experimental Physics" has usually been directed to specialized research fields. In contrast, Volume 14, *Vacuum Physics and Technology*, serves vacuum users with a wide range of research interests. The editors, Gerhard Weissler and Robert Carlson, do a commendable job in bringing coherence to a book with sixteen chapters by fifteen authors, many of whom are responsible for developments in the last two decades about which they write. Although some authors are necessarily associated with companies producing vacuum equipment, no commercialization appears in the text.

The 600-page length is both a strength and weakness: to a novice in the field it brings together many points of view in a digestible form; the old-timer, on the other hand, may be tantalized by new information but sometimes frustrated by its brevity. The volume begins with the fundamentals of gas transport, adsorption on surfaces, and measurement of total and partial pressures. Several authors are careful to contrast pumping methods, point out key design decisions in the pumpdown of a system, and give sound advice to interpret manufacturer's specifications. The 100-page compilation of the properties of materials used in vacuum surroundings is occasionally marred by misprints and lack of consistency in units. Seven chapters are concerned with the design, fabrication, operation, safety considerations, and maintenance of high and ultrahigh vacuum systems. In spite of some repetition resulting from the multiple authorship these chapters contain a wealth of useful information. The sections stressing the importance of surface area and system volume in determining performance and those that describe the proper sequencing of fabrication and cleaning steps are helpful. The final chapter is concerned with an abbreviated discussion of thin-film deposition by evaporation and sputtering.

This volume appears at an opportune time. Present vacuum processing applications in microcircuitry and plasma etching and continued growth of surface science depend on the ready availability of controlled conditions. The forthcoming submicron structures will put even harsher requirements on vacuum environments.

Saul Dushman and James Lafferty's *Scientific Foundations of Vacuum Technique* (Wiley, 1962) contains considerably more depth on gas flow than the present volume. There are more seal designs in A. Roth (*Vacuum Sealing Techniques*, Pergamon 1966), and substantially more thorough treatments of film deposition techniques and properties in several other sources. However, *Vacuum Physics and Technology* does present fundamental vacuum-design criteria and practice in a clear manner.



Array of mechanical vacuum pumps connected to a number of evaporation and sputtering systems in the Thin Film Technology Group at RCA Laboratories, Princeton, New Jersey.