Handbook of Laser Technology and Applications
Lasers: Principles and Operations
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Optical Components: Section
Introduction

Publication details
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Published online on: 24 Jun 2021

How to cite: - Julian Jones. 24 Jun 2021, Optical Components: Section
Introduction from: Handbook of Laser Technology and Applications, Lasers: Principles and
Operations CRC Press
Accessed on: 28 Dec 2023

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Chapters 12–15 are concerned with the optical and optomechanical components used to form and transport laser beams, building on the basic concepts of laser optics expressed in Chapters 2 and 5.

The topic of Leo Beckmann’s Chapter 12 is the passive components of lenses and mirrors that are used to condition laser beams. His starting point is to contrast the properties of coherent laser beams with the familiar formalism of incoherent optics and the formation of images, developing the theory of Gaussian beams. Armed with the theoretical foundations, he goes on to consider the characterization of laser beams, introducing the $M^2$ parameter and more sophisticated means for describing the wavefront. The simplest components are those with plane surfaces, causing reflections, and whose properties can be modified by thin films, either singly or in multiples. The most familiar optical component is surely the lens; nevertheless, the characteristics required for laser beam transmission are different from those in imaging systems, for reasons of high spatial coherence and power density. Methods for lens design and multiple lens systems are described and extended to mirror systems. The section closes by considering thermal effects, optical specifications and manufacturing techniques.

In Chapter 13, Alan Greenaway considers the optical components used for dynamic control of lasers, in scanning and positioning the beam, changing its size and shape, and modulating it in time and space. Relevant components for scanning are mechanical, acousto-, electro- and magneto-optic and the use of diffractive optical effects. For controlling beam shape, spatial light modulators and various adaptive optical components are appropriate. Adaptive optics and phase conjugate reflectors are the subject of Michael Damzen and Carl Paterson’s Chapter 14. Here are described the techniques first developed for astronomical imaging through the turbulent atmosphere for the correction of wavefront distortion. More recently, such techniques have been considered for intra-and extra-cavity use in lasers. They describe the relevant sensors (such as the Shack–Hartmann wavefront sensor), actuators (adaptive mirrors, faceplates, electrostatic membranes and biomorphs) and control systems. A special case of adaptive optics, in which there is no closed-loop control, is the phase-conjugate mirror, also capable of restoring distorted wavefronts to their original shape, and the uses of, for example, four-wave mixing, stimulated Brillouin scattering, photorefractivity and self-intersecting loops are all discussed.

Optical components are of little use unless they can be held in the right place (statically or dynamically) and kept there; such is the function of the optomechanical components that form the subject of Frank Leucke’s Chapter 15, which considers the formalism for optomechanical design, practical approaches and testing, with special attention to precision positioning.