Solid-State Lasers: Section Introduction

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Lasers can be categorized by whether their active medium is a solid, liquid, or gas. Solid-state lasers were the first type of lasers to be invented (ruby lasers). They have the advantage of being rugged, compact systems that make them useful in non-laboratory environments. Technically, both dielectric host materials with dopants or point defects and semiconductors are solid-state lasers; however, the common terminology is to use the name ‘solid state lasers’ for the former and ‘semiconductor lasers’ for the latter. This chapter deals with solid-state lasers while semiconductor lasers are discussed in Chapter 11.

There are a wide variety of laser host materials, including oxide and fluoride crystals and glasses. Similarly, there are many types of dopants including transition metal ions, rare-earth ions, and colour centres. It is the combination of specific dopants or point defects with specific host materials that determines the fundamental properties of the laser. These combinations can operate as three-level, four-level, and vibronic lasers spanning the near-ultraviolet, visible, and near-infrared spectral regions. They can be pulsed or continuous wave, discrete line or tunable, and mode-locked or operating in Q-switched modes. The ruggedness and versatility of solid-state lasers have led to their use in many practical applications.

This section describes the fundamental science and technology of the most common solid-state lasers and provides information on their systems design and laser operating parameters. One way to extend the spectral range of solid-state lasers is through non-linear optical effects. This section describes the use of several types of non-linear optical effects in solid-state lasers. The laser material for the systems described in this section is in the form of a rod or slab. Other configurations of solid-state lasers such as fibres and waveguides are discussed in Chapter 35.