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Rotation Stages
for Laser Power Attenuation

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ABSTRACT

This paper describes rotation stages that can be used to adjust laser power by changing the position of wave plates or polarizers. MKS instruments' SR50 and PR50 Series and the Agilis AG-PR100 motorized rotation stages are described in detail along with CONEX motion controllers that can be used for computer-control of 24/7 operation of laser power attenuators. These standard rotation stages and controllers provide a compact, cost-effective solution for supplying variable laser power in many laser machining applications.

INTRODUCTION

When laser applications require precise control of optical power, users are typically presented with one of two options. First, they may have access to lasers with inherent variable output power, e.g. q-switched lasers, fiber lasers, or fs amplifiers. With these lasers they can simply vary the optical power at the laser source and there is no need for a separate laser power attenuation device. Second, users may not have a variable power laser source, or their application may require additional laser power control. Under these conditions the user needs a simple, cost effective solution that can produce continuously variable laser power from the input laser source. This situation calls for an ancillary optical system for laser power attenuation.

Many laser applications require adjustment of the optical power during a process. For example, simply measuring the power of a high-power laser with a photodiode requires significant attenuation of the beam to avoid saturation or damage to the sensor. Attenuation is also necessary when different materials require different beam powers to achieve and maintain a desired interaction with the laser beam. In some applications, a narrow and variable range of laser power may be needed in order to minimize undesirable effects in the Heat Affected Zone or its size. Another example requiring control of the laser optical power is the scanning of a laser beam across a substrate having variable thickness or curved geometries that produce a change in the effective scanning speed and hence the effective laser power deposition. In many cases, a variable power laser may be a viable solution. However, variable power lasers can exhibit unacceptable pulse stability and beam quality alteration at low operating currents and power levels. Therefore, a fixed power laser source coupled with an ancillary laser power attenuation optical system is often the most cost-effective solution for these and other applications that require pulse stability and retention of the original laser beam parameters at lower power.

Figure 1. (a) schematic of the components of a laser beam attenuator, (b) the action of a zero order λ/2 waveplate showing the decomposition of the laser beam into two orthogonal components and polarization rotation (1)

Laser Power Attenuation

The main topic is a discussion of the need to attenuate laser beam for better and more accurate control of the output power required by many applications. One cost effective solution is to use small rotation stages that can rotate waveplates or polarizers.

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