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Lens-based adaptor system for coupling fibre optic to infrared semiconductor lasers

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European foreword

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Introduction

The common solution for coupling an infrared semiconductor laser to an optical fibre is using parabolic mirrors. This solution provides a very low optical loss because of coupling. However, using a parabolic mirror comes with a few disadvantages.

For example, such a coupling is bulky so it makes the infrared semiconductor laser-based devices bigger and difficult to assemble, which renders the final product less affordable. Additionally, if the device contains a parabolic mirror, moving it around might change the performance of the device due to mechanical vibration and might need service. Another drawback is that if an infrared semiconductor laser or fibre must be replaced, a very highly trained technician is needed to perform the replacement and coupling with the parabolic mirror. This leads to an undesirably long repair time.

Therefore, using the parabolic mirror as the fibre coupling method has three disadvantages: the bulky nature of the mirrors, being susceptible to mechanical vibration, and difficulty to service. These problems advised to look for a user-friendly and stable alternative coupling system, which will be highly beneficial for final applications of the devices. This adaptor-based coupling system makes the coupling just a plug-in process which can be done with a short training. Furthermore, using this adaptor makes the system very stable and less sensitive to mechanical vibration and shocks.

The adaptor is a lens-based coupling system, which is attached to the infrared semiconductor laser. For most infrared wavelengths, such lenses are commercially available. The lens adaptor-based coupling technique is a well-established technique for diode laser so implementation of this technique for infrared semiconductor lasers will be a smooth transition from the mirror-based coupling technique. Thus, it could be very easy for the industry to accept it as a standard method. In addition to all the technical benefits of a lens-based adaptor, the overall cost of the devices will be cheaper in comparison to the mirror-based coupling system.

The device covered by this document was firstly developed as a side result of the European, public funded research and innovation project MIRACLE 'Mid-infrared arthroscopy innovative imaging system for real-time clinical in-depth examination and diagnosis of degenerative joint diseases'. The project uses a quantum cascade laser system to create a mid-infrared attenuated total reflection (MIR-ATR) instrument for arthroscopic use. When testing the first prototypes, different performance and design problems were found related to the coupling of the laser units to the fibres, so a new solution was developed. This same solution can be useful in quite different applications in several fields for which infrared semiconductor lasers are increasingly used, such as infrared spectroscopy for different applications (pharma, biotech, environment…), medical equipment, non-metal laser processing, microscopy, laboratory tools for scientific applications, and many more.

1 Scope

This document defines design and performance requirements and guidelines for a lens-based coupling adaptor system for fibre optic, intended for coupling fibres to infrared (IR) semiconductor laser sources.

Safety requirements are not covered by this document.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— • ISO Online browsing platform: available at https://www.iso.org/obp

— • IEC Electropedia: available at https://www.electropedia.org/

4 Description of the adaptor and coupling method

The adaptor is a single-piece machined element (cap) that fits the IR semiconductor laser housing and is mechanically attached to it. Internally, it incorporates a glued lens that focuses the laser light into the fibre end facet.

The adaptor can be coupled to the IR semiconductor laser by a trained person using a microstage device with three-axis of freedom.

After coupling, the adaptor is fixed to the laser with an adhesive. This assures minimal displacement of the adaptor for reaching the highest possible coupling efficiency.

Figure 1 shows the cross section of the adaptor coupled to an IR semiconductor laser.