Deutsch-Russische Kooperation

Grundlagenuntersuchungen für einen 3 µm - Laserkonverter mit 1,12 µm - Anregung

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Abschlußbericht

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Die Kooperation mit der Forschergruppe Dr. Mironov am GOI in St. Petersburg ist sehr erfolgreich verlaufen. In regelmäßigen Verbundsitzungen, zweimal pro Jahr, teils in Ulm bzw. in St. Petersburg, wurden die Arbeitsschritte abgeklärt und termingerecht bearbeitet. Als Endprodukt wurde ein Prototyp des Laserkonverters erstellt, der an das ILM zu Testzwecken im März 1998 ausgeliefert wurde.

Im Anschluß an dieses Vorhaben kam es zu einer Industriekooperation mit der Firma Carl Zeiss, um diese Technik für ein medizinisches Gerät weiterzuentwickeln. Außerdem werden für weitere Applikationen ein EU-Projekt beantragt.

Ulm, den 27. Mai 1998

Prof. Dr. R. Steiner

BMBF Grant #13N7039

Studies of Design Principles for 3 Micron Laser-Converter Pumped at the Wavelength 1.12 Micron

Report on works performed by GOI in the frames
of BMBF Grant #13N7039

Work Leader **Igor A.Mironov**

St.Petersburg
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1. Introduction

The advantages and prospects of medical laser devices using 3-micron lasers were repeatedly discussed in scientific and industrial society, and are well known. For many applications such as minimal-invasion therapy and surgery, a fiberoptics delivery of 3-micron laser energy to the zone of operation is needed.

An approach using miniature (pencil- or match- size) 3-micron laser pumped by near-IR (1 micron range) radiation through a flexible hose was suggested and developer in the work of GOI within the frames of the Project of the International Scientific and Technological Centre (ISTC Project #149). The first models of laser-converter systems were demonstrated, and advantages (viz., higher conversion efficiency) of so-called “direct pump” spectroscopic scheme was shown. The “direct pump” scheme implies pump wavelength 1.12 microns which is absorbed directly by Holmium ions that are at the same time the ions generating 3-micron radiation.

The goal of the BMBF Grant #13N7039 is to make further steps towards the practical implementations of the laser-converter approach to 3 micron laser devices for medical applications:

- to make optimisation of laser-converter crystal composition,
- to make technological improvements on key optical components and details,
- to design and to manufacture a laser-converter model suitable for testing laser-converter at various types of biological tissues,
- to analyse the further possibilities of laser-converter approach as applied to various medical requirements.

2. Optimisation of laser-converter crystal composition

The crystal compositions both for “indirect” and for “direct pump” scheme were suggested. The table 1 shows those compositions which were studied in details within the works on BMBF Grant.

The crystals for laser-converter (LC) were manufactured with various concentrations of Ho and Pr ions. The Ho concentration was 30, 50, 70 and 99.5% at., while Pr concentration was between 0.05 to 1% at.. Laser rods were manufactured using YLF matrix with size dia.6*50mm, dia.4*50mm, dia4*20 mm. The technology of spherical rod surfaces was developed.

Table 1

PUMP LASER		LASER-CONVERTER				
Matrix	Wave length, μ	Matrix	Dopant	Concentration	Co--dopant	Concen-tration
$Y_3Al_5O_{12}$:Nd	1.12	$LiYF_4$	Ho	10-95	Pr	0.5-3
		BaY_2F_8	Ho	10-95	Pr	0.5-3

Spectroscopic studies were performed of the LC crystals grown, in order to optimize the composition of crystals for maximal conversion efficiency at repetitive pulsed operation mode. De-activation processes of the lower and upper laser levels were studied.