issn 2193-4665
Vol. 5 • Issue 2/2013

laser

international magazine of laser dentistry

2 2013

| research
Nd:YAG lasers in intraoral welding

| overview
Diode lasers for periodontal treatment

| industry report
Er:YAG laser etching of hypoplastic enamel

Summertime in Brussels is WFLD-ED laser time

Prof. Dr Norbert Gutknecht
Editor-in-Chief

Dear readers of laser international magazine of laser dentistry,

A very special event is rising on the laser horizon. Laser users, laser specialists and laser researchers from all over Europe are invited to participate in the 4th European Division Congress of the World Federation for Lasers in Dentistry (WFLD).

Coincidently, Brussels is not only the capital of the European Union, but it will also be the hosting city of the conference of the European Division (ED) of WFLD from July 11 to 12, 2013. Although this event has been announced as a European conference, participants from other parts of the world are expected as well.

Aside from the official WFLD ED Congress, the award ceremony of the European Master Certificates (EMDOLA) will be celebrated during this congress.

I think that a lot of "stimulated emission" will therefore be found under the Atomium, one of Brussels iconic landmarks, during this event.

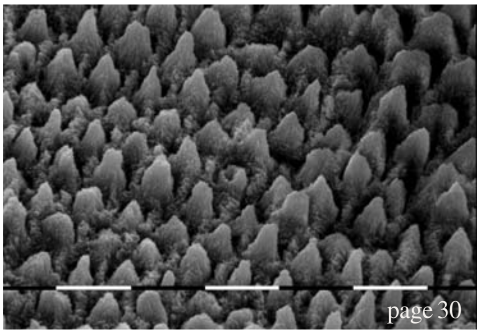
On behalf of laser international magazine of laser dentistry, I wish the organising chairman Prof. Nammour, his team, and all participants an exciting congress time in Brussels.

Yours sincerely,

Prof. Dr Norbert Gutknecht


page 22


page 26


page 30

editorial

research

overview

industry report

education

meetings

news

about the publisher

Cover image courtesy of Syneron, www.synerondental.com
background image: ©Click Bestsellers
Design by Sarah Fuhrmann, OEMUS MEDIA AG.


page 44


page 47


page 48

Syneron™
DENTAL LASERS

Education. Technology. Family.

Join the Syneron Dental Lasers Family

presenting

LITETOUCH™

The unique fiber-free Er:YAG laser
that has changed the face of laser dentistry

LI-PB7692EN

To learn more about our innovative technology solutions,
contact: dental@syneron.com, www.synerondental.com

Deloitte. Technology Fast500 EMEA 2011 Winner

Best in Biz 2013 Awards Winner

Nd:YAG lasers in intraoral welding

Author_Prof. Dr Carlo Fornaini, Italy

_Introduction

Laser welding was introduced in jewellery in the 1970s and later successfully used also by dental technicians.[1] The wavelengths that were used firstly were CO_2 and Nd:YAG, but, finally, the market was rapidly conquered by the latter because of the results that were obtained.[2] Laser welding, in fact, gives a great number of advantages in contrast to traditional welding.

First of all, the laser device saves time in the commercial laboratory because all welding is done directly on the master cast. Inaccuracies in assembly caused by transfers from the master cast and investments are reduced.[3] Furthermore, the heat source is a concentrated light beam of high power, which can minimise distortion problems on the prosthetic pieces.[4] Interesting is its possibility to weld very closely to acrylic resin or ceramic parts with no physical (cracking) or colour damage.[5] This results in saving both time and money during the restoration of broken prosthetics or orthodontic appliances because remaking to the not-metallic portions is not necessary.

Fig. 1

This welding technique may be used on every kind of metal, but its property to be very active on titanium makes it specifically qualified for prosthetics over endosseous implants.[6] Many laboratory tests demonstrated that laser welding joints have a high reproducible strength for all metals consistent with that of the substrate alloy.[7] All these advantages resulted in this procedure causing a great unrest in the technicians' laboratories and stimulated the companies to put more and more upgraded appliances on the market.

Some aspects, such as its extensive dimensions, high costs and high costs and fixed-lenses delivery system today still characterise these machines, which strictly limit their use only to technician laboratories.

The first aim of this study was to evaluate the possibility to utilise the same device normally used in dental office for laser welding. The second aim was to achieve welding directly in the mouth by employing a fibre-delivered laser after an accurate evaluation of the biological compatibility of the procedure.[8]

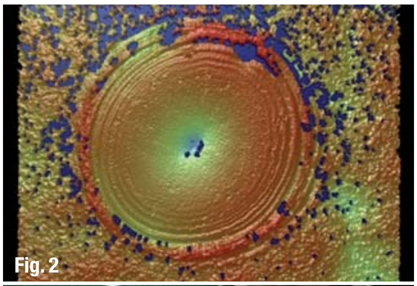


Fig. 2

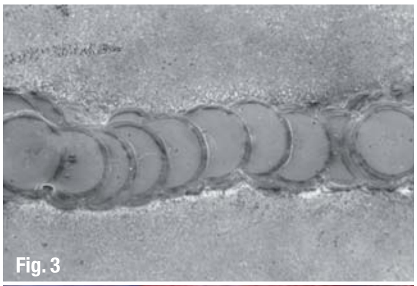


Fig. 3

Fig. 4

Fig. 5

_Material and methods

The first step of our research was to determine the wavelength most appropriate for our work among those normally used by the dentist and those applied for welding in the industrial field (CO_2—10,600 nm, Diode laser—810 nm, and Nd:YAG—1,064 nm). We made some tests on metallic plaques for each wave-



Master of Science (M.Sc.) in Lasers in Dentistry

Next Start: **23 September 2013**

Aachen, Germany

4 semesters


Become part of the International Dental Elite

- Create new economic potential for your practice
- Two year career-accompanying postgraduate programme at the University of Excellence RWTH Aachen
- Combination of lectures, skill training sessions, live ops, tutorials, and practical workshops
- Internationally accepted and accredited by the German Governent, the European Union, the Washington Accord and the Bologna Process
- Science-based and practice-orientated on highest national and international level
- Increased patient satisfaction: minimal contact reduced vibration and pain

ASIIN e.V. accredited degree program

RWTH INTERNATIONAL ACADEMY AACHEN UNIVERSITY

RWTH International Academy
Kackertstraße 10 I 52072 Aachen I Germany
phone +49 241 80 23543 I fax +49 241 80 92525
info@academy.rwth-aachen.de
www.academy rwth-aachen.de

PROFESSIONAL EDUCATION PROGRAMMES

AALZ Aachen Dental Laser Center

AALZ GmbH
Pauwelsstraße 17 I 52074 Aachen I Germany
phone +49 241 47 57 13 10 I fax +49 241 47 57 13 29
info@aalz.de
www.aalz.de

length and we saw that the one able to weld was the Nd:YAG.

While the pulse durations of the dental CO_2 laser are too short and cannot give the thermal elevation necessary to obtain a fusion of metal, the output power of the dental diode laser is too low (from 5 to 10 Watts) and cannot give the energy necessary to support a real welding process. Therefore, we decided to use the appliance FIDELIS PLUS III (FOTONA, Slovenia, Fig. 1) which combines two different wavelengths, Er:YAG (λ = 2,940 nm) and Nd:YAG (λ = 1,064 nm).

The first wavelength allows the dentist to treat hard tissues (enamel, dentin and bone) by a mechanism which causes the explosion of intracellular water molecules by utilizing the affinity of this laser with water and hydroxyapatite, thus resulting in the ablation of the tissues.[9] The Nd:YAG laser allows the dentist to perform surgery with complete haemostasis, utilising the affinity of this wavelength with haemoglobin, therefore avoiding sutures.[10] It is also employed for the periodontal pockets and root canal decontamination, for bleaching and to treat dentinal hypersensitivity.[11]

The peculiarity of FIDELIS PLUS III is given by the possibility to have pulse durations in milliseconds (15 and 25), in addition to a pulse duration in seconds, which is necessary during dental interventions. These high pulse durations can be utilised in phlebology, in the treatment of inestethisms of vascular origin, thanks to the affinity of this wavelength for haemoglobin.[12] The optic fiber delivery system is a very important advantage of this device with regard to intraoral welding, because it is very flexible and ergonomic and therefore able to penetrate into the oral cavity.


Fig. 6


Fig. 7


Fig. 8


Fig. 9

We decided to use a fiber of 900 µm in diameter, normally used for bleaching and biostimulation. Initially, a handpiece with a 2 mm spot (Fotona R 30), normally used in dermatology, was chosen and, by reducing the working distance, a spot of 1 mm was obtained. We asked the manufacturer to construct an experimental hand piece capable of generating a 0.6 mm spot. The aim was to increase fluence (J/cm^2), which is the most important parameter determining the quantity of energy delivered to a surface, by a factor of 10, while also utilising the device's maximum energy output (9.90 J).

_"*In vitro*" tests

The first *in vitro* test was conducted by irradiating CrCoMo plates with various combinations of welding parameters. The spot's configuration was analysed by an interferometric technique. Interferometry is a non-contact, optical technique for measuring surface height and shape with great speed and accuracy. Interferometry makes it possible to precisely measure the shape and size of the laser's crater in the metal surface in three dimensions, and allowed us to choose laser parameters that welded well, but minimised collateral damage to the surrounding area (Fig. 2). In these preliminary tests, the best parameters found were: output power = 9.90 W, frequency = 1 Hz, pulse duration= 15 ms, working distance = 30 mm, energy = 9.90 J, fluence = 3,300 J/cm^2.

The subsequent tests were performed on CrCoMo plates and steel orthodontic wires to compare the welding by dental laser (Fidelis, Fotona) to this obtained by the use of a device normally utilised in dental laboratories (Rofin, Germany).[14] In addition, metal fillers were used. Different techniques (Fig. 3) were employed to analyse the results: SEM (Scanning Electron Microscope), EDS (Energy Dispersive Spectroscopy) and DMA (Dynamic Mechanical Analysis). The results of the two sample groups were similar with regard to microstructure, elemental distribution on the welding fillets, strength off the joints and elastic modules.

In order to obtain a device able to weld every kind of metal and alloy, including titanium, we added an argon gas cylinder connected to a pipe to the appliance, spreading the gas to the laser impact beam by means of an additional pedal. The titanium samples welded under this shielding atmosphere did not show any trace of oxidation.

_"*Ex vivo*" tests

In order to define the thermal increase in the biological structures close to the zones which are thermally affected by the welding process (sulcus, pulp chamber, bone and root), an *ex vivo* study was performed.[15,16]

Two fresh calf jaws were kept at room temperature and holes were made in the disto-labial area in six molars of each jaw by micro motor drill. Then, four k-type thermocouples were connected to each tooth and fixed with thermoplastic paste (Impression Compound Red Sticks, Kerr) in the pulp chamber, sulcus, bone and root.

The thermocouples were then connected to a PC-integrated four-channel thermometer (LUTRON TM-946) in order to record and save the data. Twenty-four metallic CrCoMo plaques were curved to hemispherical shape (15 mm ray) and a couple of them were placed on every previously prepared tooth. Since the first examination was performed by an IR thermal camera, limited in that it only provides the surface evaluation of the jaw, it was decided to use the four-thermocouples system which, although its application is more difficult and will take longer, allows checking the internal temperature of the structures. A rise in temperature was recorded in the pulp chamber. However, for all the twelve samples tested, the maximum temperature rise was lower than 5.5 °C, which is considered a critical value for pulp vitality.

A similar test was then performed on pork jaws by welding a titanium bar to implants previously inserted into the bone under argon gas atmosphere (Fig. 4). The values recorded by thermocouples placed closely to the implants showed a thermal elevation much lower than those considered dangerous for bone necrosis (5 to 7° = protein coagulation). After these *in vitro* and *ex vivo* experiments, it was decided to apply this technique to *in vivo* clinical situations.

_Clinical cases

Case 1

A 59-year-old male patient presented with implant-prosthetic treatment which consisted in the apposition of a fixed prosthetics placed in to the upper arch with two crowns and five endosseous implants (Fig. 5). After crown preparation and impression taking, the dental technician constructed the metallic structure of the bridge in two sections to assure its fit and, to avoid the risk of inaccuracies in the impression, it was decided to connect them by intraoral laser welding.

In order to protect the soft tissues from the ejection of warm metal splinters, we utilised the silicon mass normally used to take prosthetic impressions with a little hole corresponding to the contact of the two portions of prosthesis (Fig. 6). The entire process had a duration of seven minutes, the effective welding time was 150 seconds, the parameters used were the same as described before and it was utilised a filler metal. After removing the bridge from the mouth, it was sent to the laboratory to complete its realisation (Fig. 7). During and after the welding process, the patient said the he did not felt any discomfort. After four weeks we could seal the bridge and finish the rehabilitation of the patient (Fig. 8).


Fig. 10


Fig. 11


Fig. 12


Fig. 13

Case 2

A 14-year-old female patient, in orthodontic treatment with a fixed appliance (modified "VELTRI" distaliser) for the insertion of the first premolars into the upper arch, came to our clinics for a check and we noticed that an arm of the appliance was broken (Fig. 9). We evaluated that the removal of the appliance was full of risks, in particular the impossibility to reinsert it after the repairing due to space closure. Therefore, it was decided to laser-weld the arm intraorally. In order to protect the soft tissues from the ejection


Fig. 14


Fig. 15


Fig. 16


Fig. 17