DEVELOPMENT OF A HIGH POWER LASER SYSTEM AND ITS APPLICATIONS

OPTICAL EMISSION SPECTROSCOPY OF LASER INDUCED PLASMA ON AIR

Tarelho, L.V.G.; Mirage, A.; Figueiredo, M.B.; Amaral, M.M.; Samad, R.E.; Freitas, A.Z.; Vieira Junior, N.D.

Centro de Lasers e Aplicações - IPEN/CNEN-SP

Keywords: LIPS; plasma; femtosecond lasers; air.

The LIPS (laser induced plasma spectroscopy) technique was implemented using the T^3 laser system. In an experiment using plain air, we were able to spatially characterize the high temperature (4000K-8000K) plasma. The ion spectra of the components of the air (nitrogen, oxygen and argon) were measured in the plasma.

ISOTOPE ENRICHED FILM PRODUCTION BY HIGH INTENSITY LASER DEPOSITION

[1]Tarelho, L.V.G.; [1]Mirage, A.; [1]Cordeiro, T.S.; [1]Sarkis, J.E.S.; [1]Kakazu, M.H.; [1]Samad, R.E.; [1]Freitas, A.Z.; [1]Vieira Junior, N.D.; [2]Rodrigues, N.; [2]Schwab, C.

[1]Centro de Lasers e Aplicações - IPEN/CNEN-SP; [2]Centro Tecnológico da Aeronáutica, Instituto de Estudos Avançados (CTA/IEAv)

Keywords: Isotope enrichment; pulsed laser deposition; femtosecond lasers; boron nitride.

A plasma of NB (hexagonal boron nitride, white graphite) was produced by focusing 60 fs, 0.5 mJ pulses at 1 kHz on solid samples. The ejected material, whose melting point is 2700 °C, was vaporized by the high intensity laser, being deposited in a substrate 10 cm away from the source, forming a film (FIG.1). The experiment duration was ~1 h or 3.6 10^6 s. The deposited film was then analyzed by HR-ICP-MS (High resolution inductively coupled plasma mass spectrometry). The film core presented an isotope ratio between Boron 10 and Boron 11 of 0.38 ± 0.06 meanwhile the border area presented a ratio of 0.231 ± 0.016, (natural abundance). These ratios show an enrichment efficiency of 65% on a spatial separation of 12 mm.

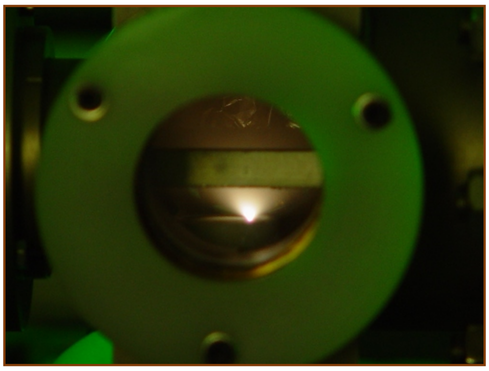

FIGURE 1 - Plasma formation and white cloud of ejected BN in vacuum. Laser intensity ~10^{15} W/cm^2.

HIGH INTENSITY LASER PRODUCTION OF COLOR CENTER DEFECTS IN CRYSTALS

Courrol, L.C.; Samad, R.E.; Gomes, L.; Ranieri, I.M.; Baldochi, S.L.; Freitas, A.Z.; Vieira Junior, N.D.

Centro de Lasers e Aplicações - IPEN/CNEN-SP

Keywords: color center; femtosecond lasers.

The production of color centers in LiF single crystals by ultrashort high intensity laser pulses (60fs, 10 GW) was achieved (FIG.2). The intensity threshold for color centers creation was determined to be 2 TW/cm^2, which is slightly smaller than the continuum generation threshold. We could identify a large amount of F centers that gave rise to aggregates such as F_2, F_2^+ and F_3^+. The proposed mechanism of formation is based on multiphoton excitation that also produce short lived F_2^+ centers. It is also shown that it is possible to write tracks in the LiF crystals with dimensional control.

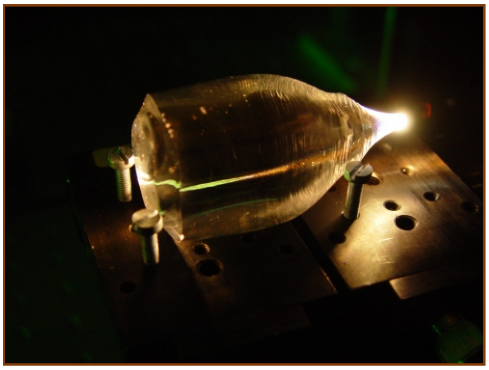

FIGURE 2 - LiF crystals under laser irradiation at 4 TW/cm2

DEVELOPMENT OF A HIGH POWER LASER SYSTEM AND ITS APPLICATIONS

GROWTH OF LARGE SIZE CR:LiSrALF$_6$ CRYSTALS

Baldochi, S.L.; Cabral, S.B.; Vieira Junior, N.D.

Centro de Lasers e Aplicações - IPEN/CNEN-SP

Keywords: laser rods; high powerlaser; larger crystals.

For the preparation of laser rods we are investigating the growth process of large Cr:LiSAF crystals. Undoped and Cr-doped single crystals of LiSAF were grown by the Czochralski technique with pulling rates of 1 mm/h, under controlled atmosphere. Crack-free single crystals over 100 mm length and diameters up to 18 mm were already pulled along the a axis (FIG.3). We are setting up our grown furnace to the growth of larger crystals (up to 30 mm in diameter and 130 mm in length). These crystals will be used as the final amplifier of the Table Top TeraWatt peak power laser system (T^3).

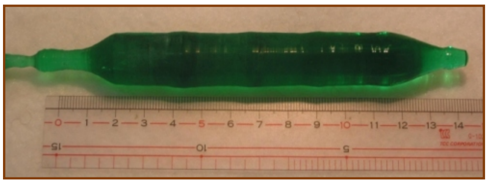

FIGURE 3 - Cr: LiSrAlF$_6$ single crystal. The laser rod is 100 mm long.

OPTICAL COHERENCE TOMOGRAPHY

[1]Freitas, A.Z.; [1]Zezell, D.M.; [1]Nogueira, G.E.C.; [1]Vieira Junior, N.D.; [2]Gomes, A.S.L.

[1]Centro de Lasers e Aplicações - IPEN/CNEN-SP; [2] Universidade Federal de Pernambuco-UFPe

Keywords: light coherence; imaging; OCT.

Optical Coherence Tomography (OCT):
A non invasive technique for imaging turbid media
The optical coherent tomography (OCT) technique is a combination of a Michelson interferometer with a broadband light source. Ti:Sapphire lasers have several tenths of nm of bandwidth, providing tenths of micrometers of spatial resolution. We have set up a dynamical scanning OCT apparatus with a resolution of ~15 μm. Therefore in one single scan we can reveal the depth profile up to 3 mm in turbid media. By scanning the whole sample area it is possible to reconstruct the 3D view of the sample. (FIG.4) shows the 3D profile of carious teeth with subclinical induced caries, that is 50 μm bellow the surface.

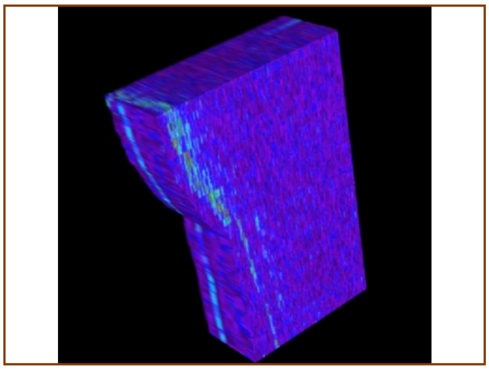

FIGURE 4 - Teeth 3D image reconstructed by OCT. The light color inside is a carious tissue, undetectable by usual means.

NONTHERMAL ABLATION BY ULTRASHORT LASER PULSES

Samad, R.E.; Freitas A.Z.; Rossi, W.; Todescan, C.; Vieira Junior, N.D.

Centro de Lasers e Aplicações - IPEN/CNEN-SP

Keywords: LIPS; plasma; femtosecond lasers; air.

Due to the very short pulse duration, femtosecond laser systems are capable of nonthermal interaction with the matter. With our system providing more than 10 GW of peak power in 60 fs pulses, hydroxyapatite ceramic material (tooth) was machined. A theory was developed that allows the determination of the ablation threshold by a simple geometrical method. (FIG.5) shows the result of fs laser 8 passes in hydroxyapatite, where a very sharp finish structure is clearly seen.

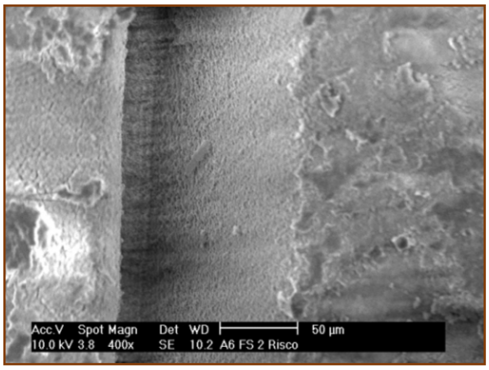

FIGURE 5 - Ablation of hydroxyapatite by 60 fs pulses with 0.5 mJ energy per pulse. The sharp edge shows the nonthermal effects.