K 8: Poster II

Time: Thursday 16:30–18:30 Location: Poster.V

K 8.1 Thu 16:30 Poster.V

Design considerations for argon excimer laser produced in a discharge using plasma electrodes — •Norbert Böwering — Ringstr. 21, 33619 Bielefeld, Germany

The design of a discharge-produced vacuum ultra-violet argon excimer laser at 126 nm is discussed. In this case study, system operation should be done with purified argon in a cooled high-pressure vessel at densities above 4×10^{20} cm^{-3} with deposited energies of about 1 Jcm^{-3} into an excitation volume of ~ 10 cm^{-3}. A modified corona-discharge triggered cooled spark gap may serve as main switch. Streamer-free homogeneous discharges can be obtained by means of ceramic-enclosed plasma electrodes. Charge transfer of 10 J of stored energy via pulse-shaping in a high-voltage, low-inductance peaking circuit enables the required ultrafast current rise time. A damage-resistant optical configuration with conditioned optics consisting of high-reflector, output coupler and transmission window is proposed. At realistic conversion efficiencies, generation of laser pulses with few ns duration and energies of above 10 mJ/pulse can be expected.

K 8.2 Thu 16:30 Poster.V

Optimierung des LIBS-Signals zur chemischen Abbildung von Metallen durch Femtosekunden Doppelpulse — •Jutta Mildner[1], Cristian Sarpe[1], Nadine Götte[1], Dirk Otto[1], Waldemar Wessel[2], Eugen Merdian[2], Angelika Brückner-Foit[2], Matthias Wollenhaupt[1] und Thomas Baumert[1] — [1]Universität Kassel, Institut für Physik und CINSaT, Heinrich-Plett-Str. 40, D-34132 Kassel, Germany — [2]Universität Kassel, Institut für Werkstofftechnik - Qualität und Zuverlässigkeit, Mönchebergstr. 3, D-34125 Kassel, Germany

Es wird ein auf fs-LIBS basiertes Rasterabbildungsverfahren zur chemischen Analyse von Metallen mit hoher räumlicher Auflösung vorgestellt [1]. Um das Abbildungsverfahren zu optimieren, müssen sowohl die spektrochemische Sensitivität als auch die räumliche Auflösung erhöht werden. Da die verschiedenen Anregungsprozesse im Festkörper zeitlich voneinander getrennt sind [2], kann die Dynamik dieser Prozesse durch die Anwendung zeitlich geformter fs-Laserstrahlung (Doppelpulse) gezielt angesprochen werden. Der Einfluss der Verzögerungszeit auf das LIBS-Signal wurde über einen großen Zeitbereich von 100 fs bis hin zu mehreren ns untersucht. Es konnte an Aluminium ein um eine Größenordnung höheres Signal erzielt werden. Darüber hinaus wird der Einfluss der Intensitätsverhältnisse zwischen beiden Laserpulsen diskutiert und Analysen der Ablationsstrukturen (via Rasterkraft- (AFM) und Rasterelektronenmikroskopie (REM)) gezeigt.

[1] W. Wessel *et al.*, Eng. Fract. Mech. **77**, 1874–1883 (2010)
[2] B. Rethfeld *et al.*, Applied Physics A **79**, 767–769 (2004)

K 8.3 Thu 16:30 Poster.V

On ripple formation in various metals and super-hard tetrahedral amorphous carbon films in consequence of femtosecond laser irradiation — •Andy Engel, Manuel Pfeiffer, Steffen Weissmantel, and Katja Günther — Hochschule Mittweida, Technikumplatz 17, 09648 Mittweida, Germany

Ripple formation in consequence of ultrashort laser pulse irradiation of materials is a well-known phenomenon. We have investigated the formation of ripples in various metals, i.e. steel, tungsten carbide hard metal, as well as in superhard ta-C films, where we used femtosecond laser pulses of 775 nm and 387 nm mean wavelength and 150 fs pulse duration. The aim was to investigate how the ripple parameters depend on irradiation parameters, and if such ripples have a potentiality for applications. In the paper, we will show that on smooth surfaces the ripple orientation is perpendicular to the electric field vector of the linearly polarized laser beam, as is well-known. Moreover, it will be shown that the ripple period decreases with decreasing laser wavelength and/or increasing angle of incidence of the laser beam on the substrate. By using optimum parameters large areas of the materials and films can be rippled swiftly, which would be important for applications. For instance, we investigated their use as diffraction gratings for the generation of optical effects. The improvement of frictional and wear behavior of tribologically stressed surfaces by ripples was investigated on ta-C coated steel surfaces.

K 8.4 Thu 16:30 Poster.V

Temporal femtosecond pulse tailoring to control the ionization mechanisms in high band gap materials — Cristian Sarpe, •Nadine Götte, Jens Köhler, Thomas Winkler, Matthias Wollenhaupt, and Thomas Baumert — Universität Kassel, Institut für Physik und CINSaT, Heinrich-Plett-Str. 40, D-34132 Kassel, Germany

The generation of high density free electron plasma is the first step in the laser ablation of dielectric materials. We have shown that tailored ultrashort laser pulses are suitable for robust manipulation of optical breakdown, increasing the precision of ablation one magnitude order below the optical diffraction limit [1, 2]. Here we present our studies to investigate the dynamics of the free electron plasma created by bandwidth limited and shaped femtosecond laser pulses in a thin water jet. By using an extremely stable common path spectral interferometer the phase shift and the contrast of the interference fringes produced between a reference and a probe pulse give accurate information about the density of the plasma and its absorption coefficient. The experimental data are in good agreement with simulation, which are based on a numerical solution of a rate equation of the free electron density [3]. Our measurements directly prove that asymmetric temporal shaped pulses can control the ionization mechanism through which the free electrons are generated in high band gap transparent dielectrics.

[1] L. Englert et al. Opt. Express 15, 17855 (2007)
[2] L. Englert et al. Appl Phys A 92, 749 (2008)
[3] J. Noack and A. Vogel IEEE J. of Quant. El. 35, 1156 (1999)

K 8.5 Thu 16:30 Poster.V

Femtosecond laser pulse interaction with hydrogenated amorphous silicon (a-Si:H) thin films — •Babak Soleymanzadeh[1], Christof Neumann[1], Christian Strüber[1], Matthias Hensen[1], Pavel Prunici[2], Andreas Gondorf[2], Helmut Stiebig[1,2], and Walter Pfeiffer[1] — [1]Physik Fakultät, Universität Bielefeld, Universitätsstraße 25, 33615 Bielefeld — [2]Malibu GmbH & Co. KG, Böttcherstraße 7, 33609 Bielefeld

Femtosecond laser pulse interaction with thin films of hydrogenated amorphous silicon (300nm thickness) is investigated. Amplified ultrashort laser pulses (from 0.04mJ to 0.13mJ pulse energy, 800nm centre wavelength, 40fs pulse duration) are focussed onto the surface either using a parabolic mirror or a lens leading to focus diameters of 15μm and 105μm, respectively. The laser treated spots are analyzed by optical microscopy (OM), scanning electron microscopy (SEM), Raman spectroscopy, and height profilometry. The ablation threshold increases significantly with focus diameter from < 300mJcm^{-2} for the small focus diameter to >400mJcm^{-2} for the large one. Well below the ablation threshold the recrystallization of the amorphous layer and a significant surface swelling is observed. Applying the same total fluence distributed on two consecutive pulses (1ms separation) also changes the ablation behavior. The laser induced surface swelling and the topography of the ablation spots indicate that the laser induced release of hydrogen strongly influences the ablation dynamics.