NITROGEN LASER BEAM INTERACTION WITH SOLID SURFACES

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Introduction and experimental setup

The use of pulsed UV lasers in meterial processing such as thin-films depositon, surface cleaning, surface etching, etc., has great interest.

Experimental investigations of laser-produced plasmas of Cu, Si and Ti are described in this contributon. The UV nitrogen laser (λ = 337.1 nm), emitting pulses of 6 ns duration with a maximum energy density of 1.1 J/cm^2 has been used. The spectroscopically pure target surfaces were almost perpendicular to the beam axis. The laser radiation was focused onto the metalic surfaces. During irradiation, the targets were in vaccum at a base pressure of 0.1 mbar or in air at atmospheric pressure. The produced plasmas (a part at about =0.1 mm above the target surface) were imaged onto the entrance slit of single prism quartz spectrograph (Carl Zeiss Q-24). The observed spectral range was from 240 nm to 550 nm. About 100 pulses onto target were necessary to produce a satisfactory spectrum on film (Ilford HP-5 film). A Jobin-Yvon projection densitometer was used for the densitometric work.

Results: electron density and electron temperature of the Cu,Si and Ti plasmas

The spectra of the solid plasmas produced in vacuum (p = 0.1 mbar) and in air (normal pressure) were deduced from the photographic record. Spectral lines were studied in detail by scanning the film in a densitometer with a narrow and short slit, selecting the part corresponding to the mximum of intensity of plasmas radiation. Relative line intensities provided data for the derivaton of the electron temperature under the assumption of LTE. The transition probabilities for these lines were taken from literature [1], [2] . The dense produced plasmas Stark broadening is the dominant broadening mechanism and the elctron density can be deduced from the measuring FWHM of a line [3]. Specialy, the needed Stark broadening parametars for Ti –line (368.5 nm) were calculated by J. Hey [4].

On the Cu , Si and Ti plasmas we obtained electron densities of the order of 10^{18} cm^{-3} (±60%), some lower in vaccum than in air . The same result is observed on Al and Mg plasmas in air [5,6]. The electron temperatures were about 1.4 eV for Cu, Si, Al and Mg plasmas. In plasmas only single ionized atoms were detected.

But the electron temperature on Ti plasmas is higher: it is (2.7 ± 0.4) eV for both Ti plasmas produced in vacuum and in air. This should be the direct consequence of the wavelength of the N_2-laser being in the vicinity of resonance lines, which lead to lower thresholds for breakdown and to a strong ionization of the Ti-plasmas. Only in Ti plasmas were observed Ti III ions beside Ti II ions.

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References:

[1] W.L. Wiese, G.A. Martin; NSR DS (1989)

[2] W.L. Wiese, J.R. Fuhr: J. Phys. Chem Ref. Data 4, 2 (1975)

[3] H.R. Griem: „Spectral line Broadening by Plasmas“, Academic Press (1974)

[4] J. Hey: private communication

[5] Ž. Andreić, V. Henč-Bartolić, H.-J. Kunze: Physica Scripta 47, 405 (1993)

[6] S. Pleslić, Ž. Andreić: FIZIKA A 14, 1 (2005)