APPEARANCE OF Be II 436.1 nm LINE WITH FORBIDDEN COMPONENT IN LIBS PLASMA

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Abstract

In this work study of LIBS on BeO target in low pressure gas mixture of Ar (97 %) and H2 (3 %) using a nanosecond pulsed laser with 266 nm wavelength is presented. The appearance of forbidden component of Be II 436.1 nm was observed and presented in comparison with the previously acquired results for pulsed gas discharge plasma.

Experiment

- Nd:YAG Q-switched laser (Quantel, Q-switch 450) at 266 nm, repetition rate 10 Hz, pulse energy 70 mJ at 266 nm
- L: biconvex achromatic lens (f = 100 mm)
- S: shutter
- M and M: optical mirrors
- Elbert-type spectrometer (9.6 equipped with a grating of 1180 grooves per mm)
- ICCD camera (Andor Technology, model DH734I-18U-03, with 1024 x 1024 pixels, 13 x 13 μm size, 18 mm intensifier diameter).

Diagnostic of plasma parameters

For LIBS method, the chamber was filled with 10 mbar of gas mixture of Ar (97 %) and H2 (3 %). For determination of N, experimental profile of the Hα line fitted with Voigt function was used. Stark halfwidth, was determined and introduced in:

\[ N = 10^9 \times \left( \frac{\lambda}{\lambda_{W}} \right)^{1.098} \]

T was estimated from the ratio of Be II 407.3 nm/Be I 457.3 line intensities, using formula:

\[ \frac{I_{407.3}}{I_{457.3}} = \frac{g_A \lambda N_e}{2(2\pi m_k n)} \frac{E_i-E_f-E_{\Delta E}}{kT_e} \]

where: \( E_i \) is ionization potential, \( E_f \) is energy of transition, \( E_{\Delta E} \) is ionization potential lowering.

Results

Temporal evolution of Be II 436.1 nm with forbidden component in LIBS plasma

Forbidden component, transition \( 3p^6 3d^2 \frac{F}{4} F'_{4} \), is easily seen on the blue wing of Be II, transition, \( 3p^6 3d^2 4d^2 \frac{D}{2} \).

Pulsed discharge vs. LIBS

Wavelength peaks separation \( \alpha \) and peaks intensity ratio \( F/A \) dependence upon \( \alpha \) for Be II 436.1 nm line with forbidden component for:

a) pulsed discharge plasma b) LIBS plasma

Spatially resolved Be II 436,1 nm line in LIBS plasma

Conclusion

Slight discrepancy between \( s/\mu \) values for two experimental setups exists. More notable discrepancy is observed for \( F/A \) values. Reason for this may be presence of self-absorption and spatial inhomogeneity in both experimental setups.

In the next step of investigation, \( N_e \) and \( T_e \) will be determined using spatially resolved measurements of Be and H lines. Also, correction for self absorption will be performed.

Since there were no dust particle observed, as assumed, results obtained from LIBS experiment may be used to evaluate the effect of dust particles on Be line parameters obtained from gas discharge.

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