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

Laboratory for plasma spectroscopy and lasers

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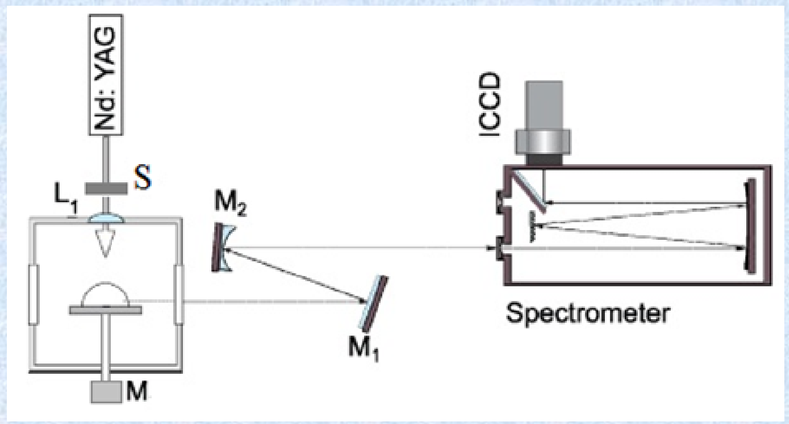
Abstract

In this work study of LIBS on BeO target in low pressure gas mixture of Ar (97 %) and H_2 (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-smart 450) at 266 nm, repetition rate 10 Hz, pulse energy 70 mJ at 266 nm
- L_1 biconvex achromatic lens (fl = 100 mm)
- S - shatter
- M - motor
- M_1 and M_2 optical mirrors
- Ebert-type spectrometer (f/8.6 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).

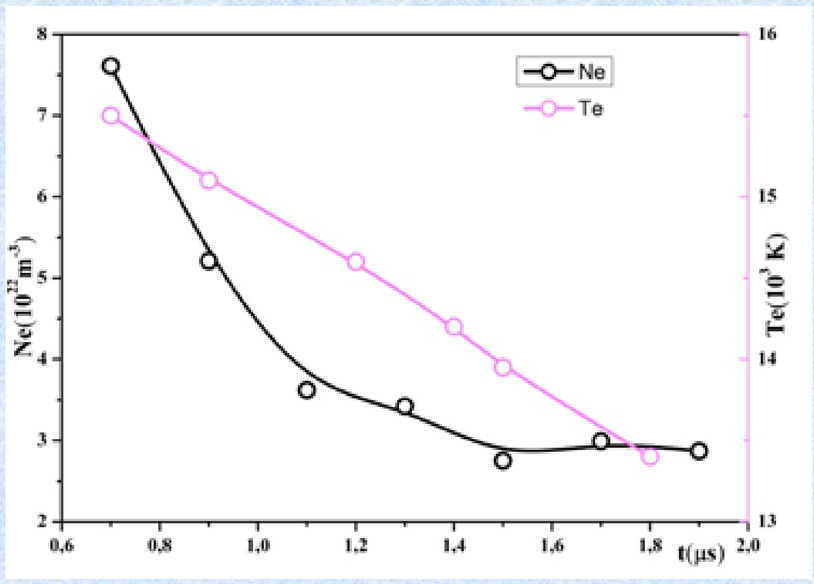
Diagnostic of plasma parameters

For LIBS method, the chamber was filled with 10 mbar of gas mixture of Ar (97%) and H_2 (3%).

For determination of N_e experimental profile of the Hα line fitted with Voigt function was used. Stark halfwidth, w_S, is determined and introduced in:

$$N_e[m^{-3}] = 10^{23} \cdot (w_S[nm]/1.098)^{1.47135}$$

T_e was estimated from the ratio of Be II 467.3 nm/Be I 457.3 line intensities, using formula:

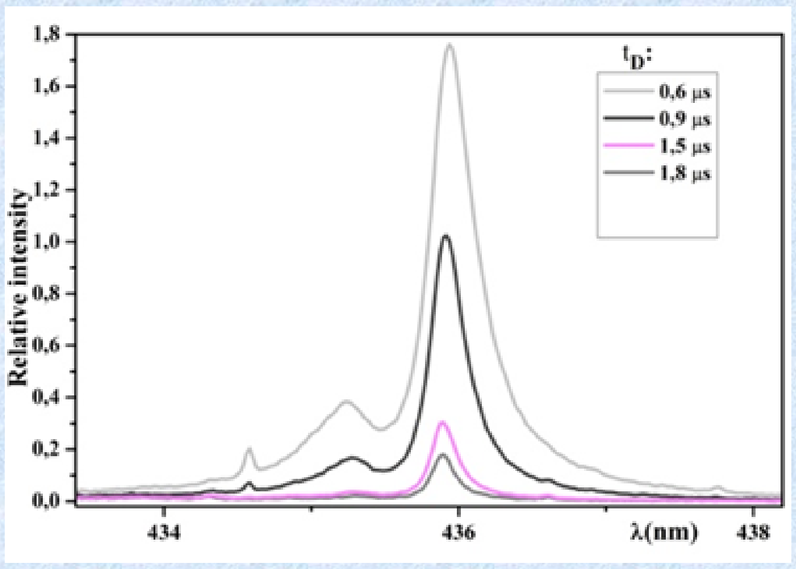


Temporal evolution of N_e and T_e for LIBS on BeO target

$$\frac{I_1}{I_2} = \frac{h^3}{2(2\pi mk)^{3/2}} \frac{(gA)_1 \lambda_1 N_E}{(gA)_2 \lambda_2 T_e^{3/2}} \exp\left(\frac{E_2 - E_1 + E_1^{ion} - \Delta E}{kT_e}\right)$$

$E_1{}^{ion}$ is ionization potential
ΔE is ionization potential lowering

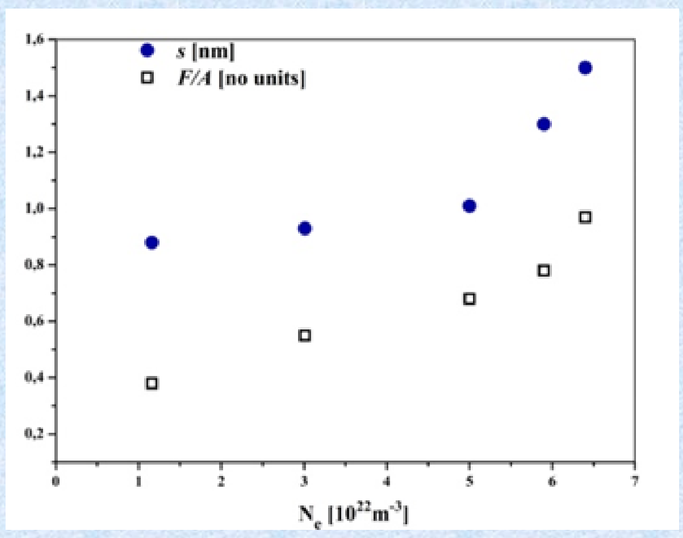
Results



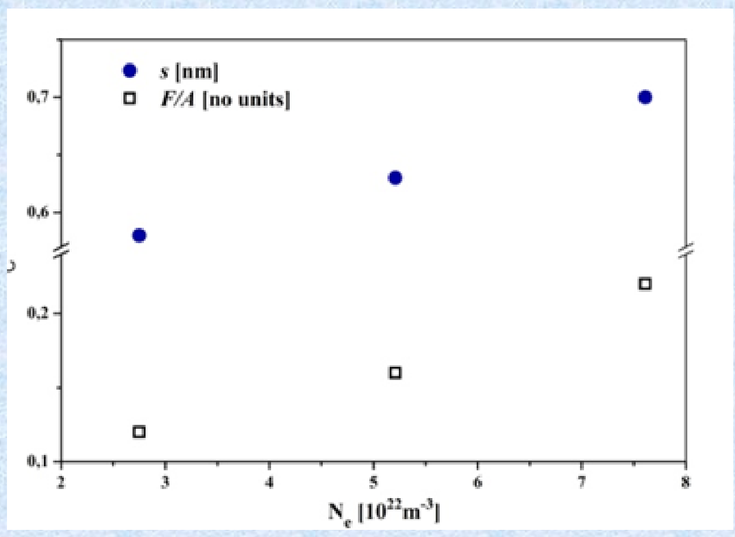
Temporal evolution of Be II 436.1 nm with forbidden component in LIBS plasma

Forbidden component, transition $3p^2\ P - 4f^2\ F^o$, is easily seen on the blue wing of Be II, transition, $3p^2\ P^o - 4d^2\ D$.

Pulsed discharge vs. LIBS

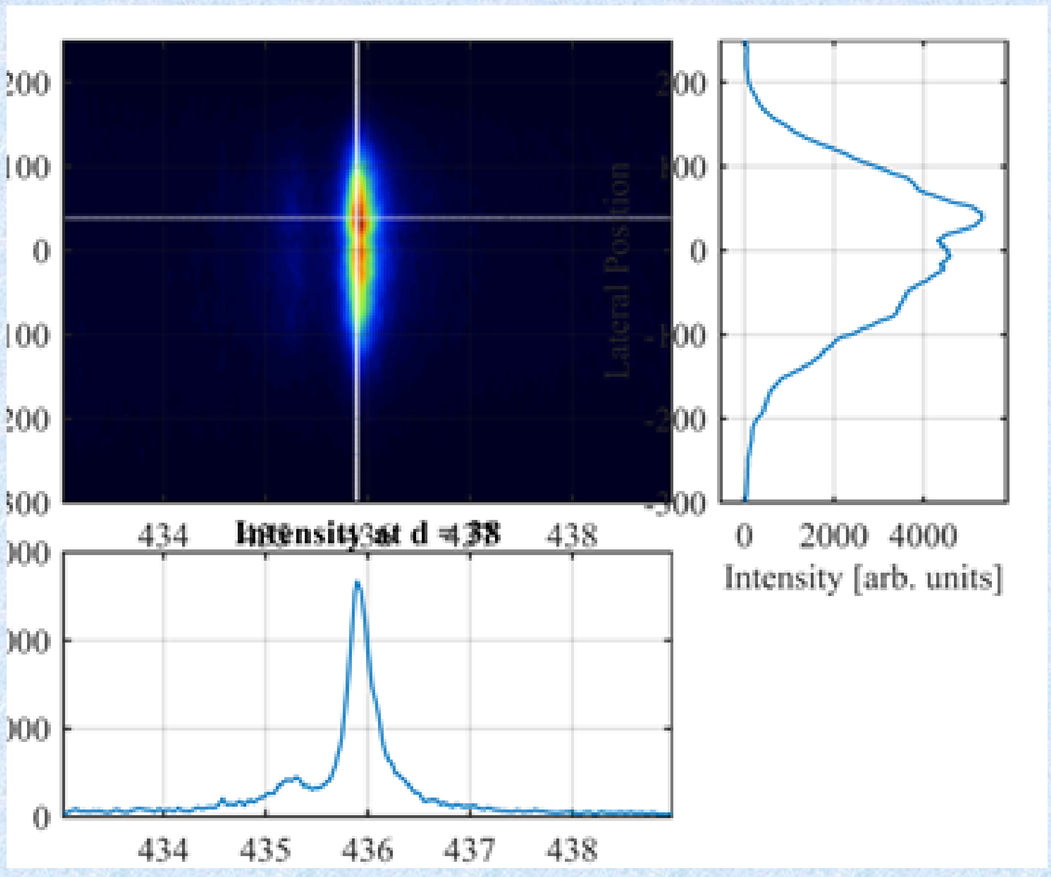


a)



b)

Wavelength peaks separation *s* and peaks intensity ratio *F/A* dependence upon *Ne* 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[nm] 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 inhomogenity in both experimental setups.

In the next step of investigation, *Ne* and *Te* 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.