



DECEMBER 11-12, 2025
۲۱ و ۲۰ آذر ماه ۱۴۰۴



دومین کنگره
پلاسما پزشکی ایران
The 2nd Congress on Plasma Medicine

دبیرخانه دائمی کنگره
پلاسما پزشکی ایران
www.plasmamedsym.ir



Pulsed Argon Arc Plasma Light as a New Tool for Efficient and Rapid Bacterial Inactivation

Motahare Aminjarrahi^{1,2*}, Farshad Sohbatzadeh^{1,2*}, Saeed Mirzanejad^{1,2},
Reza Ebrahimnezhad Darzi^{1,2}, Mohammad Rezanejad³

¹Department of Atomic and Molecular Physics, Faculty of Science, University of Mazandaran, Babolsar, Iran

²Plasma Research Center, University of Mazandaran, Babolsar, Iran

³Department of Electrical Engineering, Faculty of Engineering and Technology, University of Mazandaran, Babolsar, Iran

OPEN ACCESS

Citation:

Aminjarrahi M, Sohbatzadeh F, Mirzanejad S, Ebrahimnezhad Darzi R, Rezanejad M. Pulsed Argon Arc Plasma Light as a New Tool for Efficient and Rapid Bacterial Inactivation. *Iran Biomed J. Supplementary* (2026): 5.

ABSTRACT

Introduction: Healthcare-associated infections pose a significant global threat. The limitations of conventional chemical disinfectants and continuous-wave UVC light have prompted the search for rapid, effective, and chemical-free alternative technologies. This study introduces a novel pulsed argon arc plasma light (PAAL) system as an efficient, rapid, and chemical-free alternative to conventional continuous-wave UVC germicidal lamps (GUV) for surface disinfection.

Materials and Methods: A lab-made PAAL system, utilizing argon gas at pressures of 40, 60, and 80 mbar and operating at 1 Hz, was fabricated. Its efficacy in inactivating *Escherichia coli* (ATCC 25922) and *Staphylococcus aureus* (ATCC 25923) was quantitatively evaluated and compared to a standard 15W GUV lamp. Bacterial colonies on agar plates were treated at a distance of 4 cm. The inactivation percentage was determined through digital image analysis after incubation. Additionally, optical emission spectra and UVC irradiance were characterized.

Results and Discussion: The PAAL system produced a broad optical spectrum with intense UVC emission lines. Increasing the argon pressure to 80 mbar significantly enhanced UVC irradiance, reaching 3195 $\mu\text{W}/\text{cm}^2$ at 254 nm—four times that of the GUV lamp (800 $\mu\text{W}/\text{cm}^2$). For *E. coli*, the PAAL system achieved a 99.9% inactivation rate in 30 seconds (30 pulses), consuming only 1,677 Joules. In contrast, the GUV lamp required 900 seconds and 13,500 Joules to achieve a 99.6% inactivation rate. Similarly, the more resistant *S. aureus*, the PAAL system achieved 98.4% inactivation in 30 seconds, outperforming the GUV lamp (97.9% in 900 seconds). Statistical analysis confirmed the significance of pulse count and gas pressure.

Conclusion: The novel PAAL system demonstrates a paradigm shift in no-touch disinfection, offering superior speed, energy efficiency, and compactness compared to conventional GUV lamps. It holds exceptional promise for rapid decontamination cycles in clinical settings to combat healthcare-associated infections.



This article is licensed under a Creative Commons Attribution-NonDerivatives 4.0 International License.

Keywords: Argon Plasma Light, Bacterial Inactivation, *E. coli*, Pulsed Light Disinfection, *S. aureus*

Corresponding Authors: Motahare Aminjarrahi and Farshad Sohbatzadeh

Department of Atomic and Molecular Physics, Faculty of Science, University of Mazandaran, Babolsar, Iran; Plasma Research Center, University of Mazandaran, Babolsar, Iran; E-mail: aminjarrahi03@gmail.com; f.sohbat@umz.ac.ir



Iranian Biomedical Journal Supplementary (February 2026): 5