

Inactivation of pathogenic bacteria by mid-infrared laser pulses



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ABSTRACT

In this work, we investigated the possibility of inactivation of pathogenic bacteria *P.aeruginosa* by exposing it to fs laser pulses of mid-IR range a wavelength, corresponded to the characteristically vibrations of proteins, lipids and nucleic acids of bacterial cell, and comparison it to UV inactivation. Inactivation of the UV laser demonstrates complete disinfection, infrared exposure reduces the number of colony-forming units by several orders of magnitude. The presence of a PET film does not prevent the penetration of laser radiation and shows the same results of inactivation as in its absence.

FT-IR OPTICAL DENSITY SPECTRUM OF BACTERIA 0,20 P. aeruginosa 0,16 C $1510 - 1700 \text{ cm}^{-1}$ C=N, C=O of amides H $I,2x10^5$





Bacteria *P.aeruginosa*, placed on CaF₂ plates, were irradiated by fs laser mid-IR laser irradiation with a radiation wavelength, corresponded to the characteristically vibrations of proteins, lipids and nucleic acids of bacterial cell: $\lambda_1 \approx 3.13 \ \mu\text{m}, \lambda_2 \approx 6.45 \ \mu\text{m}, \lambda_3 \approx 352 \ \text{nm} \ \tau \approx 250 \ \text{fs}$, maximum average power is 40 mW (3 µm) and 39.5 mW (6 µm), 60 mW (352 nm), repetition rate: 10 kHz.

The 6-µm laser pulses (1650–1750 cm⁻¹) corresponding to:

- >C=O-bond in nucleic acids (1680–1715 cm⁻¹),
- C=O stretching vibrations of ester groups from lipids and fatty acids (~ 1740 cm⁻¹),

The **3-\mum laser pulses** (wavenumber spectrum of 2700–3050 cm⁻¹) corresponding to:

• C–H asymmetric stretching vibration in $-CH_2$ and $-CH_3$ fragments of fatty acids and lipids in the bacterial cell wall in the range of 2800–3000 cm⁻¹.

PET FILM TRANSMITTANCE



MICROBIOLOGICAL TEST



Microbiological results of inactivation pathogenic bacteria after treatment UV laser pulses (352 nm), middle IR laser pulses (3 and 6 mkm), bacteria samples coated with a PET film by UV and IR (6 mkm) laser pulses; K+ - control. Exposition time is 3 minutes.

The research was supported by the Ministry of Science and Higher Education of the Russian Federation (Project No. 075-15-2020-775).

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