

RESULT OF RESEARCH

RESEARCH PARTNERS

National Institute of Laser, Plasma and Radiation Physics, National Institute of Materials Physics
Horia Hulubei National Institute of Physics and Nuclear Engineering, Department of Life and Environmental Physics Polytechnic University of Bucharest |
Faculty of Biology, Department of Microbiology and Immunology, University of Bucharest.

APPLICABILITY

Medical engineering | Advanced Materials | Laser technologies

DENUMIRE REZULTAT

Functionalization by the MAPLE technique of the surfaces of medical devices with composite coatings showing magnetic and electrochemical properties for applications in hyperthermia.

DESCRIPTION

Functionalization of the surfaces of medical devices with composite coatings showing magnetic and electrochemical properties with applications in hyperthermia.

Multifunctional metallic implants based on magnetic and conductive polymers sensitive to external stimuli have the potential to revolutionize medical therapies, such as cancer treatment or osteomyelitis management, by attacking the affected tissue and inhibiting cancer cells without damaging the surrounding healthy tissue.

The study (N. Stefan, A.I. Visan, V. Grumezescu, V. Kuncser, A. Kuncser, N. Iacob, G. Schinteie, M. Socol, C. Florica, I. Zgura, R.C. Popescu, A.M. Holban, G. Socol, MAPLE deposition of hybrid PLGA-Fe₃O₄- Cypress-PEDOT: PSS coatings, Giant, Volume 18, 2024, 100250, ISSN 2666-5425, <https://doi.org/10.1016/j.giant.2024.100250>; anita.visan @inflpr.ro; gabriel.socol@inflpr.ro) aimed to combine the properties of magnetic nanoparticles with the antimicrobial activity of essential oils to create new nanobiosystems, which can be used as coatings for medical implants. These coatings are resistant to bacterial adhesion, making them useful in hyperthermia applications. Local hyperthermia involves heating a small area of interest (tumor) by applying an external magnetic field, or electrically stimulated delivery of an active therapeutic agent by applying an external electric field. The hyperthermic effect can be used to destroy tumor cells which are more sensitive to temperatures of around 45 °C compared to healthy cells. Unlike classical therapies such as chemotherapy or radiotherapy, these new approaches are less invasive, highly effective and easily controllable.

MAPLE (matrix-assisted pulsed laser evaporation) technology enables the fabrication of these coatings with substrate adhesion, controllable thickness and high homogeneity, offering significant advantages in tissue engineering.

Magnetite nanoparticles are suitable for in vivo applications because they can be manipulated by an external magnetic field and destroy tumor cells by the hyperthermic effect. The essential oil of cypress (*Cupressus sempervirens* L.) was chosen for its antimicrobial activity and multiple therapeutic properties, showing both antibacterial and antifungal activity, with the intention of being released controlled by the action of an electromagnetic field.

The biodegradable and biocompatible polymer PLGA (poly(lactide-co-glycolide)) is introduced into the proposed system in order to protect the degradation of essential oils and increase its stability. Also, the conducting polymer PEDOT (poly(styrene sulfonate) anion-doped poly(3,4-ethylenedioxythiophene)) is used to potentiate the electrical activation of the coatings.

The study reports the deposition of hybrid coatings using the MAPLE technique, creating implants based on magnetite nanoparticles and cypress essential oil embedded in PLGA and PEDOT. These implant prototypes have proven to enable local and controlled drug release, adjusted by external stimuli, thus improving the treatment efficacy and the biocompatibility of the implants, while also inhibiting the formation of the microbial biofilm.

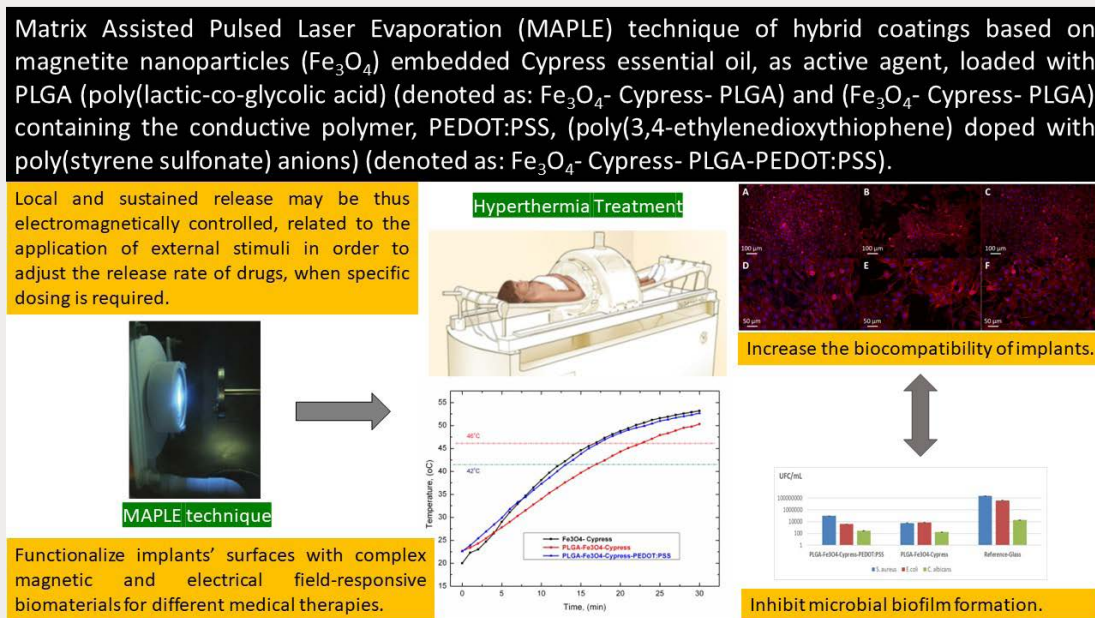


Fig 1. Abstract Graph

The "Laser-Surface-Plasma Interactions" laboratory led by Prof.Dr. Ion N. Mihăilescu - ion.mihaiulescu@inflpr.ro - from the Laser Department has over 40 years of experience in the field of laser applications in medicine, biology, sensors, optoelectronics, laser-surface interactions, material processing with lasers and generated plasmas with laser (<https://lspl.inflpr.ro/>).

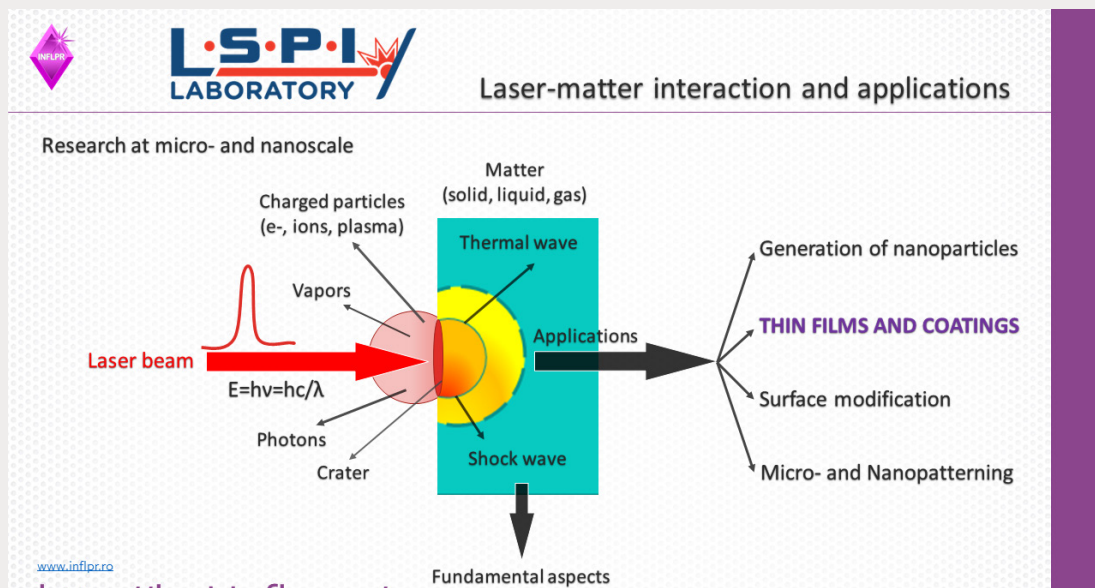


Fig 2. Expertise Presentation