Novel, fast and high-performance water-soluble photoinitiators for the fabrication of specific biomaterials using 3D-VAT printing

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INTRODUCED NOVELTIES

This solution proposes a series of novel water-soluble radical photoinitiators that can be used to fabricate precision polymeric materials for biomedical applications. The initiators allow the introduction of a functional additive into the additive process - 3D printing, and the resulting materials - 3D hydrogels- are characterized by high optical resolution, even for micrometer-sized components.

SPECTROSCOPIC CHARACTERISTICS

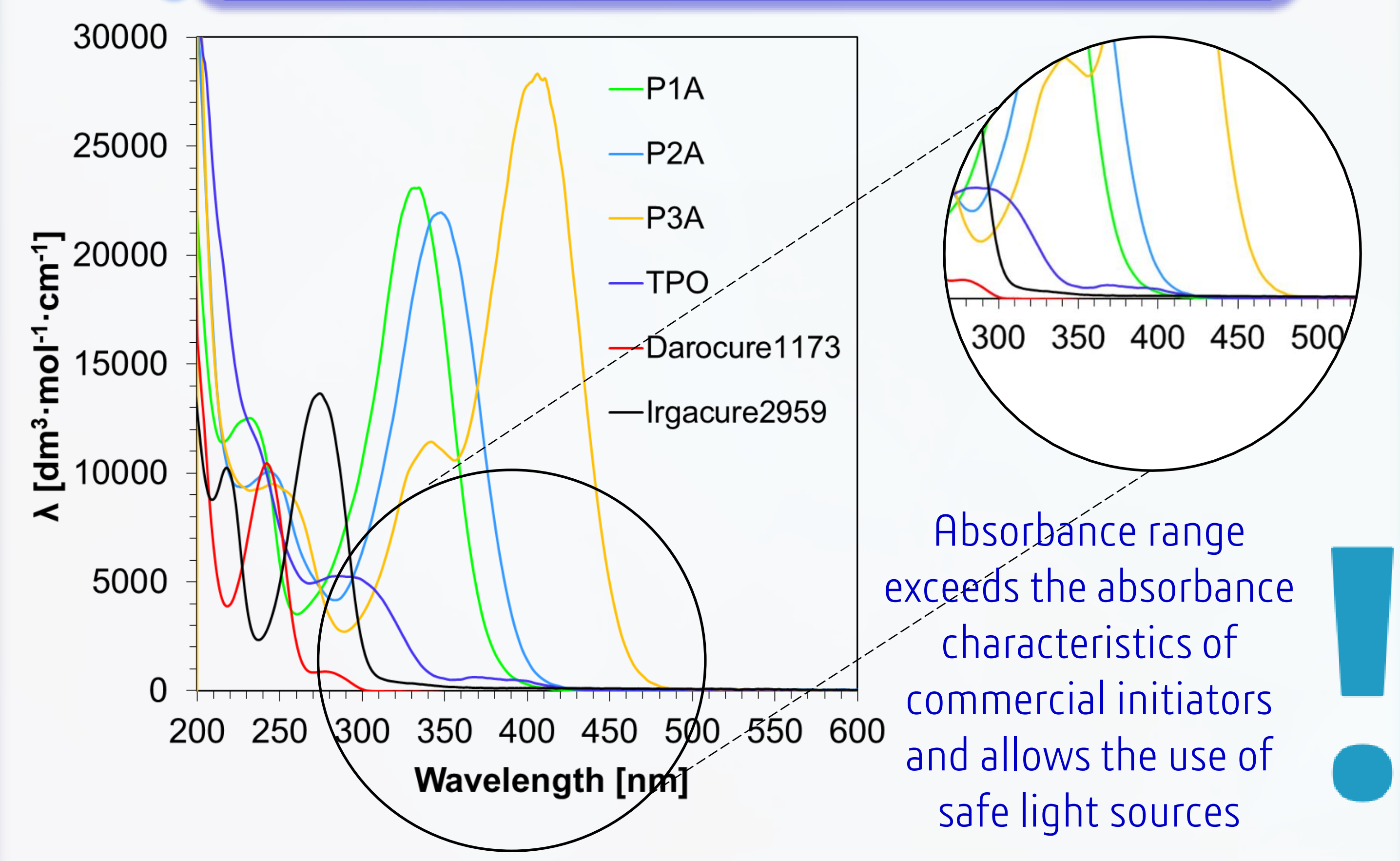


Fig. 1. Absorbance characteristics of exemplary initiators being the subject of the invention and absorbance spectra of common commercial initiators.

PRINTING OF PRECISE SHAPES WITH MICRO-SCALE ELEMENTS

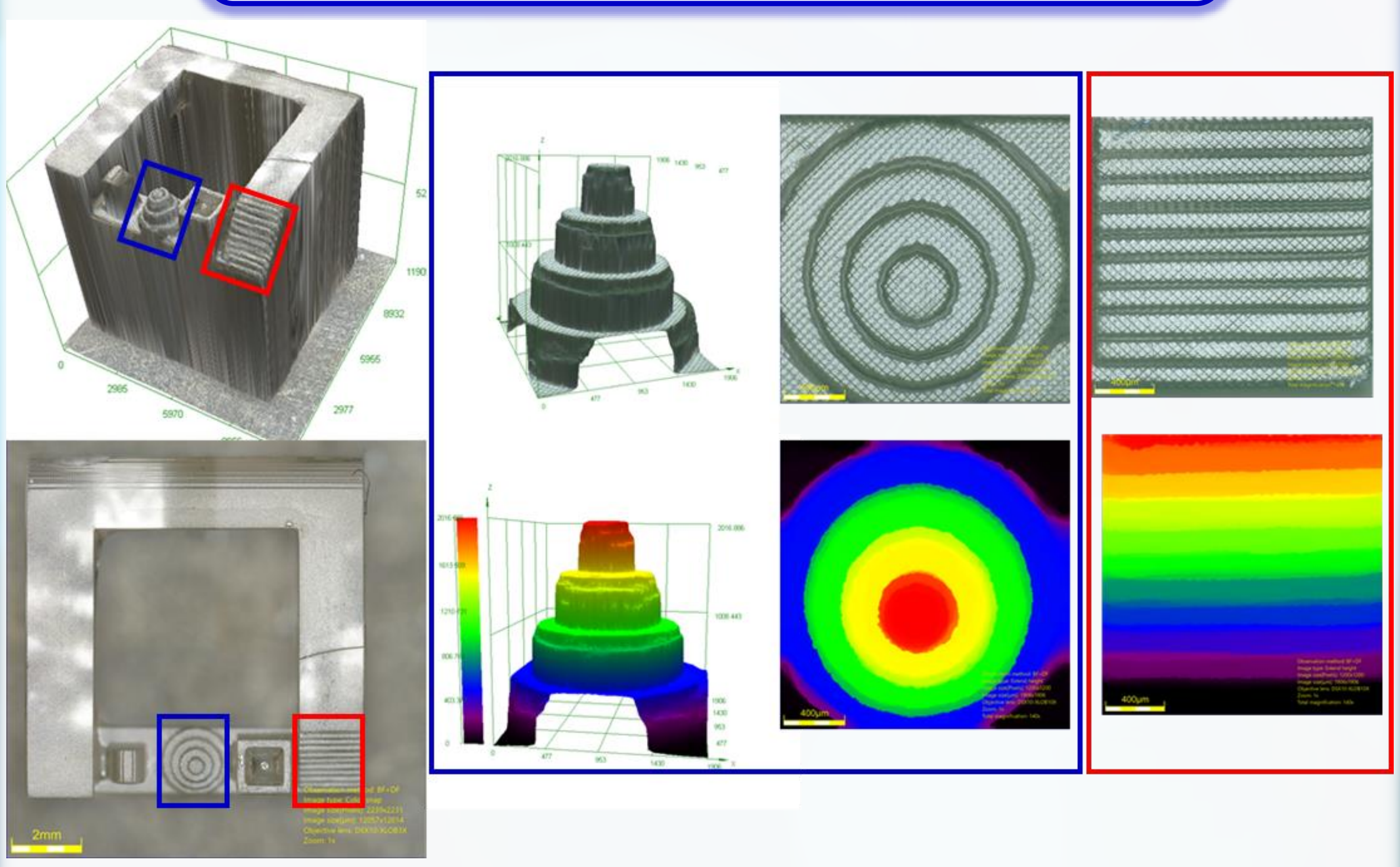


Fig. 2. Photographs taken with an optical microscope (from Olympus) of a printout obtained with the use of developed photoinitiators, with close-ups on individual elements.

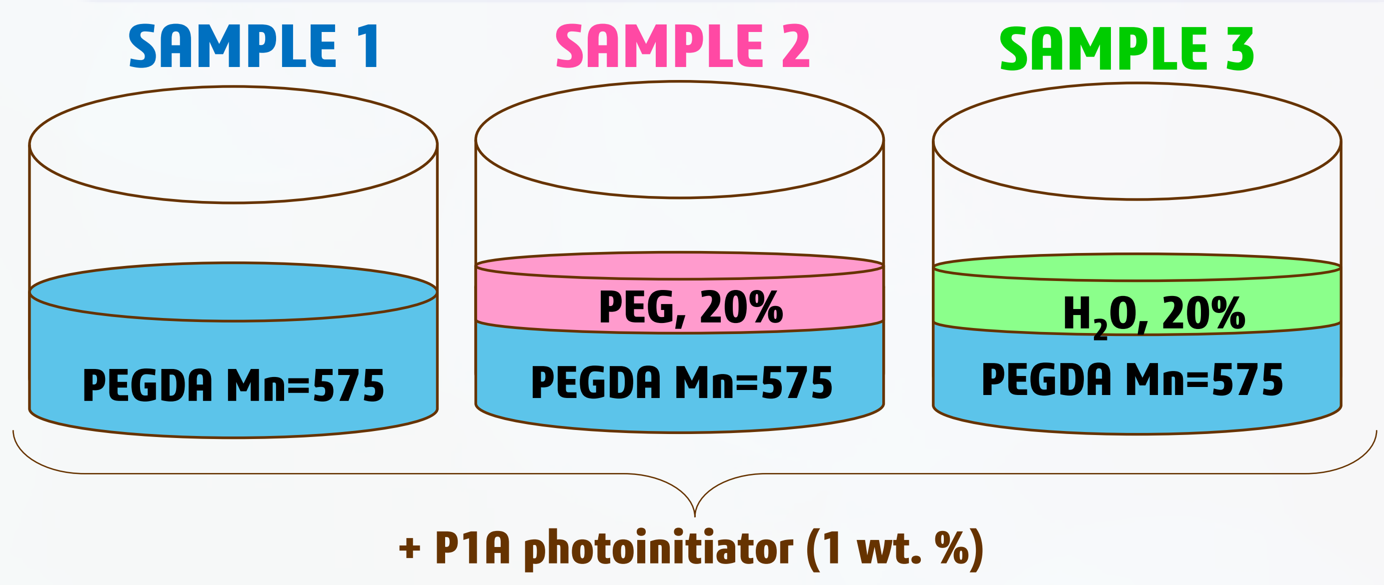
HIGHLIGHTS OF THE INVENTION

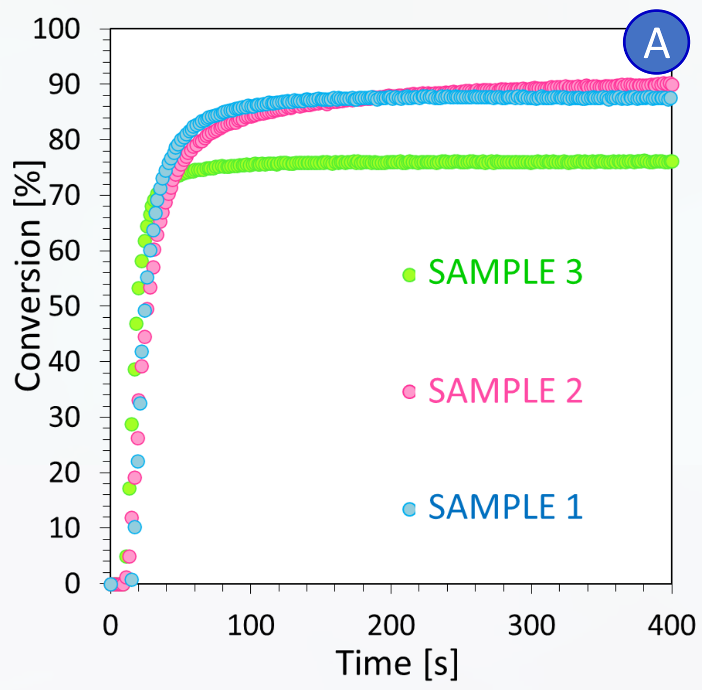
- ✓ photoinitiators are well soluble in water, which enables their implementation in biomedical applications where a safe solvent such as water is used;
- ✓ photoinitiators have suitable absorption characteristics allowing their effective use in processes using a safe range of light (visible light, such as Vis-LEDs);
- ✓ these photoinitiators are characterized by high efficiency, providing a fast process of radical photopolymerization and high conversion rates of reacting monomers;
- ✓ these photoinitiators are well suited for use in additive technologies, more specifically in 3D-VAT printing to obtain hydrogel material;
- ✓ these photoinitiators are able to initiate polymerization with both "pure" bio-resins and resins containing a functional nano-additive (without weakening the properties of the final product) ;
- ✓ the obtained hydrogel materials are characterized by high optical resolution, even for micrometer-sized elements.

COMPARISON OF THE SOLUTION WITH THE CURRENT STATE OF THE ART

The presented solution is an alternative approach to initiators based on phosphine oxides used so far, which are characterized by poor solubility in water and mutagenic action of some of them causes an application gap for 3D-VAT printing processes. The developed novel photoinitiators address a number of requirements that are placed on such compounds when used in biomedical applications.

GYRIOD TYPE HYDROGELS PRINRING AND MONITORING OF THE REACTION





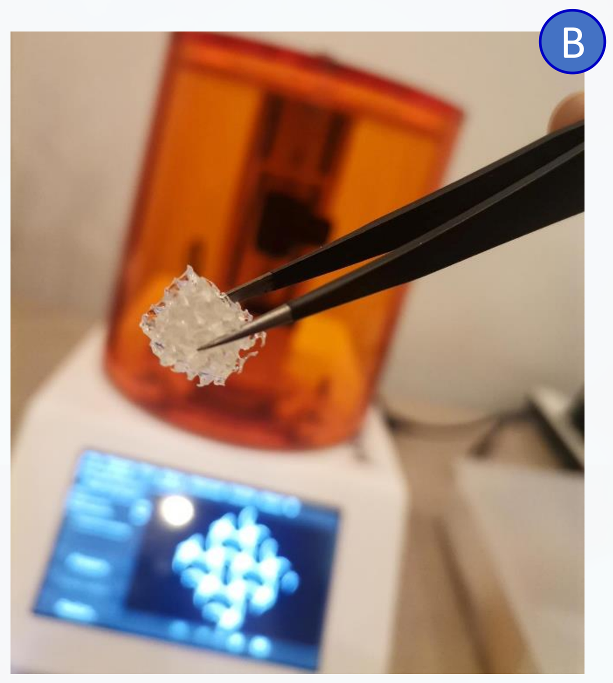
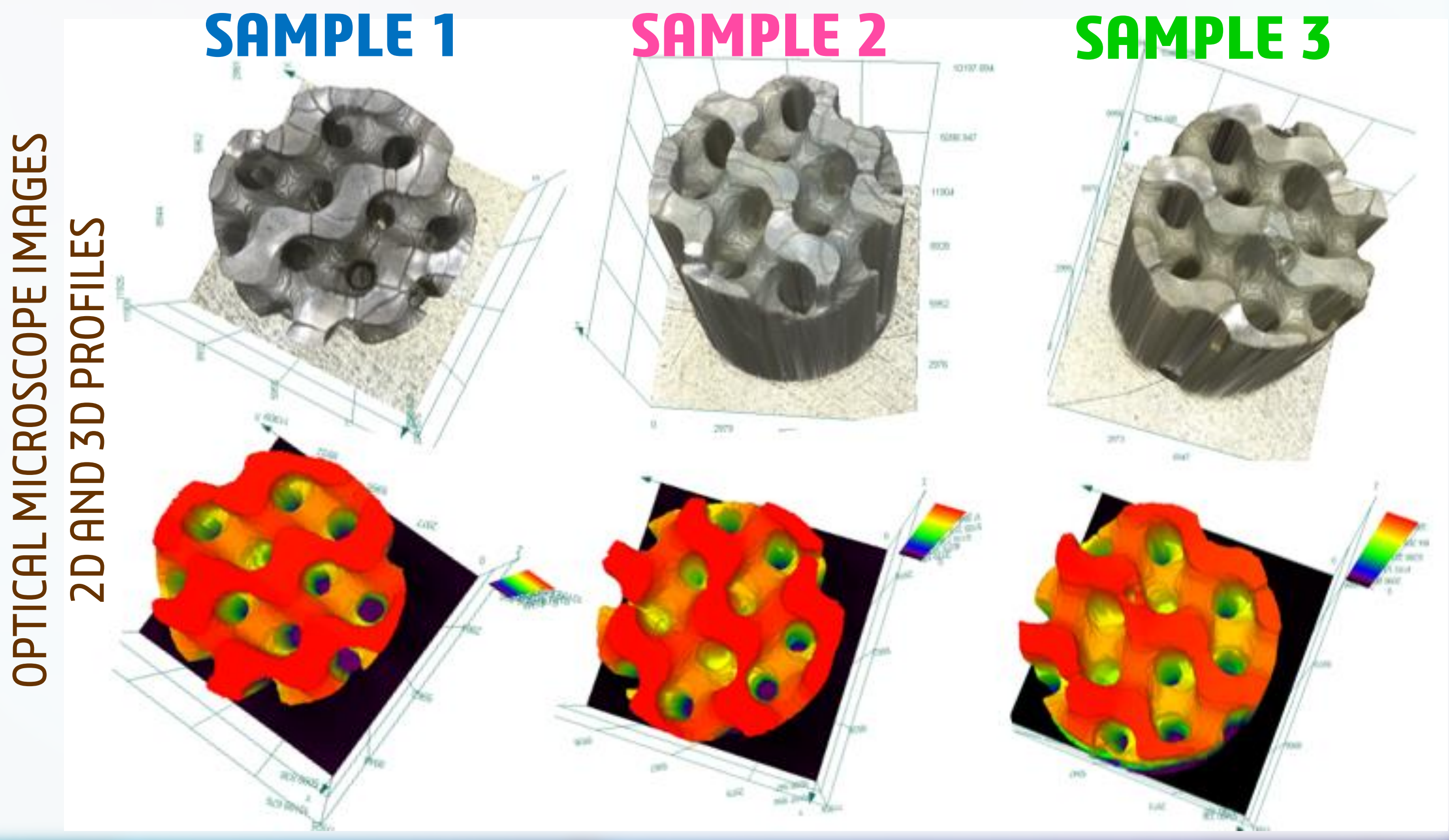


Fig. 3. (A) Kinetics of the radical photopolymerization process during the preparation of hydrogel materials under 405 nm light irradiation, with an intensity of 1000 mA , **(B)** Photo of the obtained gyroid cube-shaped hydrogel (photo in the background of the 3D printer used to prepare the material: LumenX, by CellInk).



EXCELLENT ACCURACY AND PRECISION IN RECREATING THE COMPUTER DESIGN

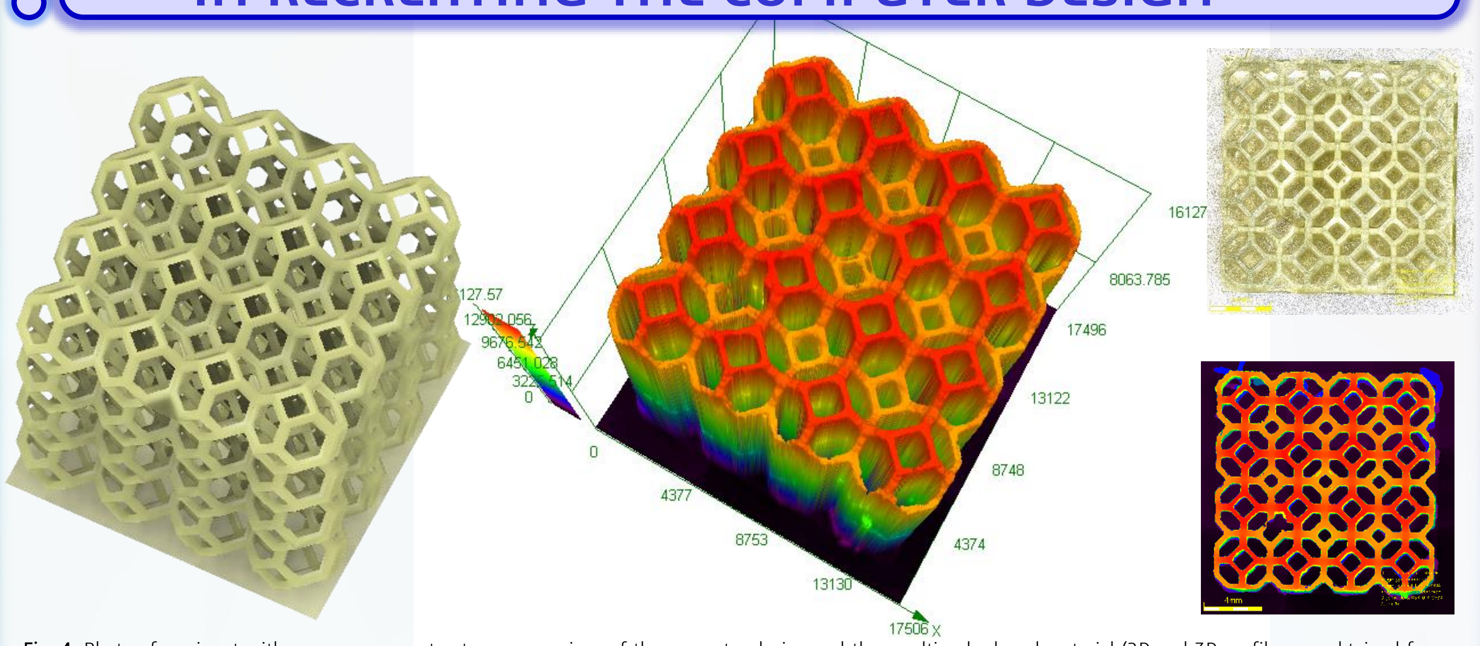


Fig. 4. Photo of a printout with a macroporous structure; comparison of the computer design and the resulting hydrogel material (2D and 3D profile map obtained from optical microscope).

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