INSTITUTE OF PHYSICS

PHOTONICS CENTER

THERMORESPONSIVE, BIOCOMPATIBLE HYDROGELS FOR RAPID PROTOTYPING OF BIOMIMETIC MICROCHANNELS

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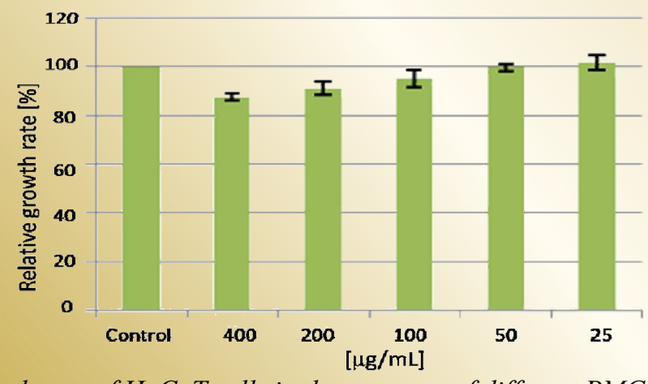
- Microchannels are mainly used in biomedical devices and microfluidic applications.
- Rapid prototyping of biophotonic structures that effectively mimic tissue microchannels was always a complex task.
- Different methods are used for microchannels fabrication:
  - PDMS moulding
  - photolithography
  - 3D printing...
- Various types of materials used for microchannels fabrications including:
  - polymers
  - glass
  - silicon...
- However, most of these methods are mainly very complex, multistep, time-consuming, expensive processes, and require use of the poisonous chemicals.
- Here we present the technology based on:

  a homemade direct laser writing device (laser operating at 488 nm, with maximal output power of 100 mW).

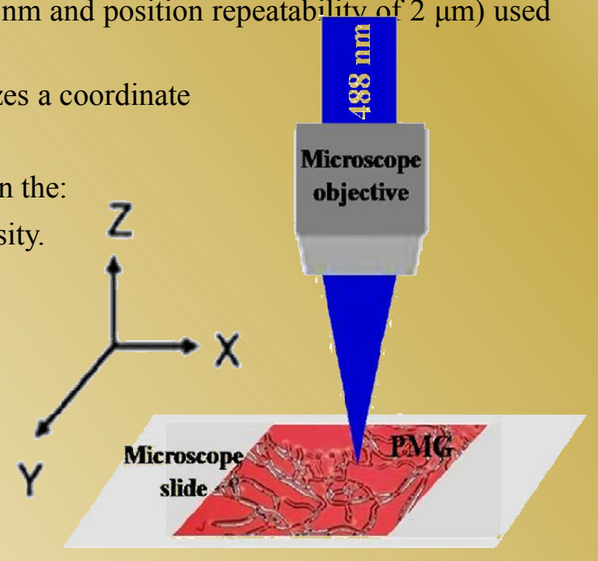
  a low-cost photomeltable gel (PMG) composed of gelatine (5% w/v), mixture of plasticisers, humectants, preservatives, and sensitizer (eosin Y dye) prepared in suitable proportions .
- Optically transparent, elastic PMG layer was prepared by the gravity settling method on a clean microscope glass slide, and dried 24h under normal laboratory conditions (T = 25°C, RH = 50 - 60%).

- *In vitro* testing of the material biocompatibility showed that PMG is nontoxic, with respect to the HaCaT cell line.



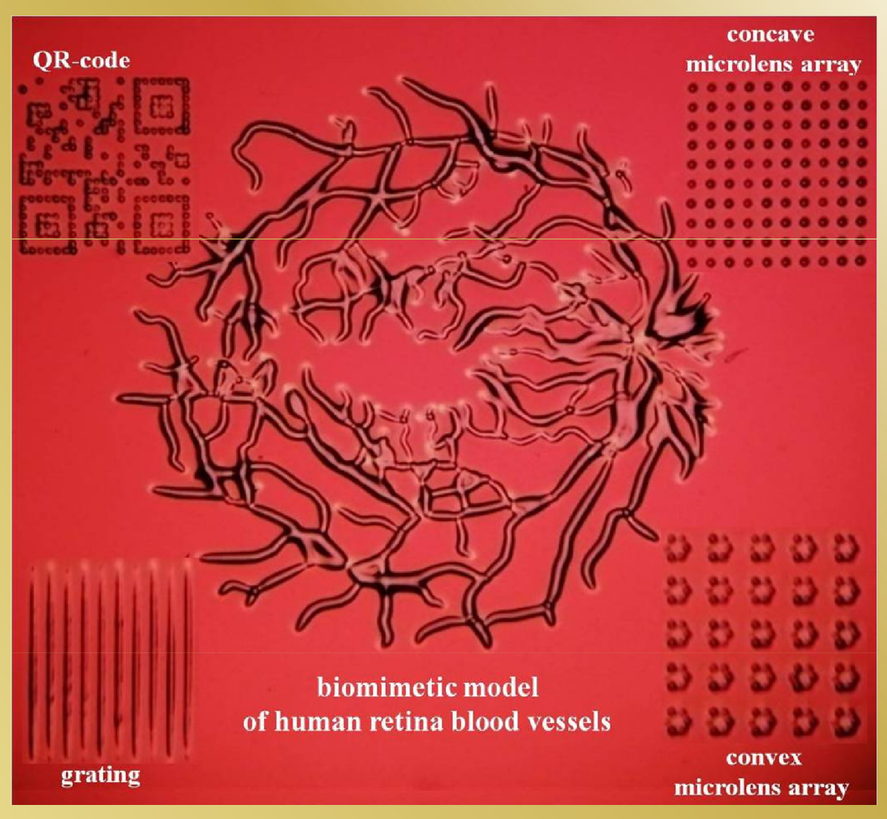
Relative growth rate of HaCaT cells in the presence of different PMG concentrations

- Microchannels were produced by locally PMG layer melting with a blue laser irradiation.
- The laser beam was focused by a microscope objective (50 0.55NA) on the sample mounted on a XY translation stage (step resolution of up to 25 nm and position repeatability of 2 µm) used for positioning the PMG layer.
- Software developed in Microsoft Visual synchronizes a coordinate translation stage, and the laser shutter.
- The physical properties of microchannels depend on the: gel absorbance, surface tension, and laser energy density.



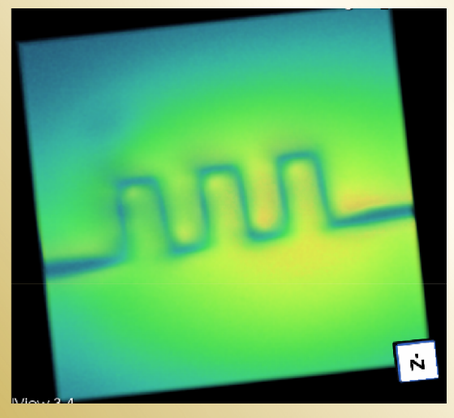
Microchannells fabrication on the PMG layer

- **As a proof of concept, biomimetic microchannels (BM) were fabricate to imitate a human retinal blood vessels.**

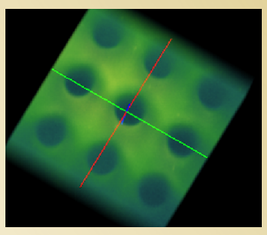


A variety of microoptical structures produced on the PMG layer

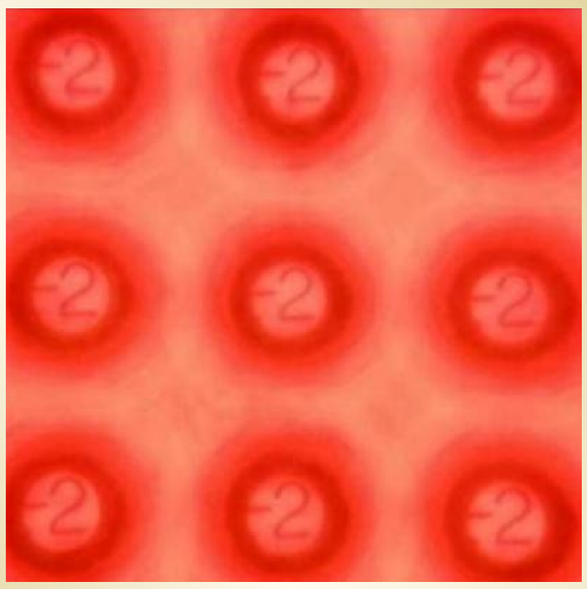
- The application of PMG is not limited only to the microchannels.
- Also, microoptical structures such as: convex or concave microlenses, diffraction gratings, holograms was produced on PMG layer.
- A homemade nonlinear microscope (NLM) equipped with a femtosecond TI: Sapphire laser (Coherent, Mira,900F) was used to characterize micro-structures.



3D image of a PMG microchannals recorded by NLM



3D image of a PMG microlens recorded by NLM



An image of digit "-2" taken by a digital camera through the optical microscope and 3x3 PMG convex microlens array

SUMMARY

- Chemicals used to prepare photomeltable gel (PMG) are nontoxic, as confirmed by biocompatibility tests.
- PMG is easy to prepare, cheap, biocompatible, ecofriendly, elastic, optical transparent, durable material.
- Microstructure fabrication is rapid, single-step process with the possibility of using a cheap lasers.
- A variety of microoptical components (microlenses, gratings, holograms...) can be produced.
- They can be used immediately follow fabrication without additional chemical processing, and any waste.
- Biomimetic microchannels (BM) has important potential for a wide range of applications:
  - noninvasive medical diagnostic
  - biomedical testing
  - security...
- A retinal vascular model to study blood flow in different pathophysiological conditions was proposed.
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