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Hierarchical Nanomotor-Loaded Microcarriers Adorned with Upconversion Nanoparticles: Function for Enhanced Imaging and Therapy

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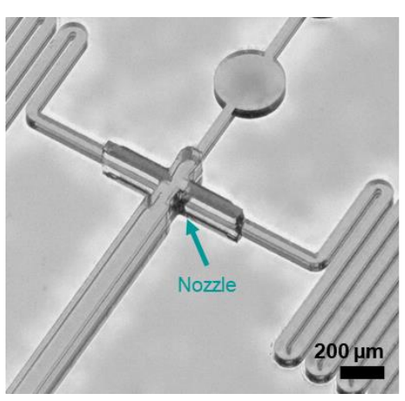
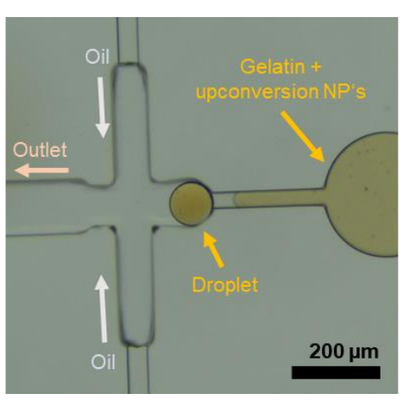
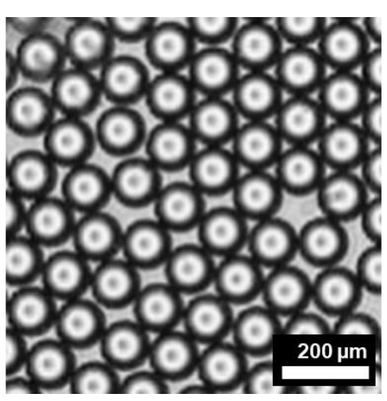
1. Concept

Revolutionizing tumor treatment through biodegradable microcarriers delivering nanomotors for enhanced imaging and targeted therapy

2. Microcarriers fabrication



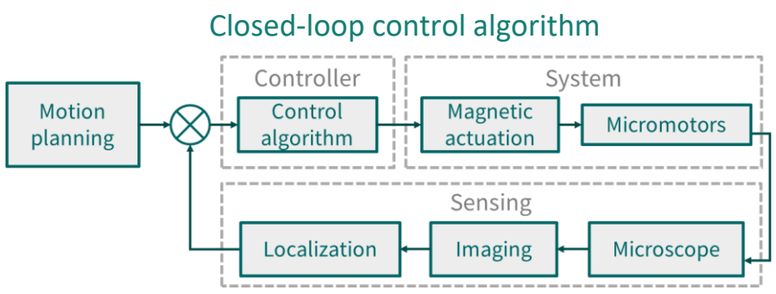


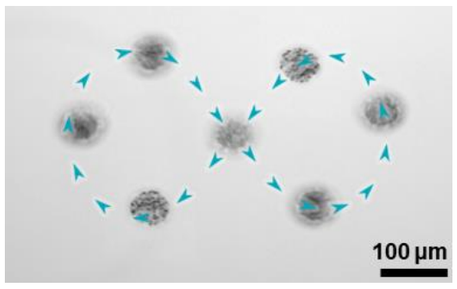


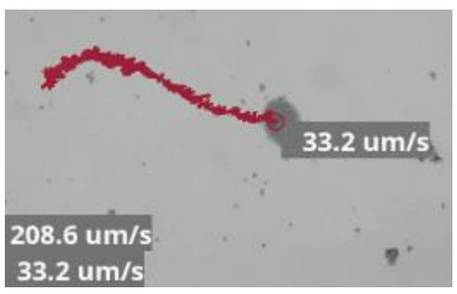
- Droplet microfluidics for Ø=100µm
- Gelatin used as soft matrix
- Integrated nanomotors
- Monodisperse sizes (M.I. <0.12%)
- High throughputs (~10^2 droplets/s)
- Small droplet volumes (~10^{-9} liters)

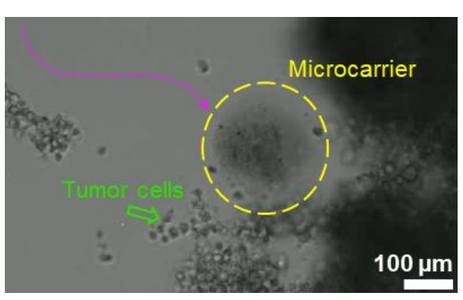
- Mass production of microcarries
- Encapsulation of nanomotors and fucntional materials

3. Magnetic control









- Embedded magnetic NP's
- Rotation and rolling motion (20mT)
- Velocity ∝ field rotation frequency
- Arbitrary trajectories planned and traced via real-time closed-control
- Optimal frequency of rotation

- Microcarriers approached to tumor
- Degradation by proteases
- Encapsulated nanomotors released
- Nanomotors propelled within tumor

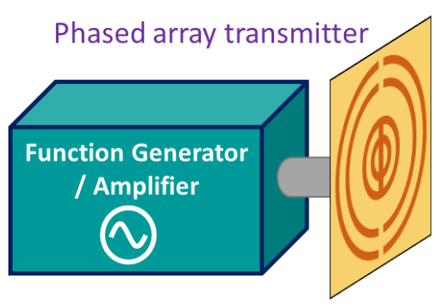
4. Up-conversion action

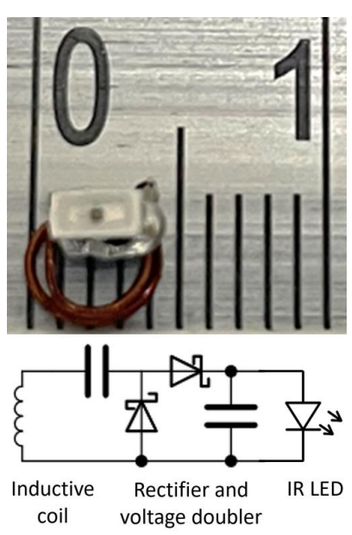
Up-conversion NP's:
- Excitement: 975nm
- Fluorescence: 805nm

Equipment:
- IR LED: 980nm
- Bandpass filter: 800nm

- Nanorobots functionalized with upconversion NP's
- NP's enhance imaging contrast and penetration depth
- Activation by a miniaturized implantable light source

- Illumination activated wirelessly
- Up-conversion triggered be LED λ





5. In vivo results

- Wireless LED sutured into the mice peritoneum
- Observation of UCNP-loaded microcarriers

- Successful in vivo imaging, facing contrast and depth penetration limitations
- Enhancements in light source and imaging improved signal detection, showcasing therapeutic potential

6. Conclusion

1. Successful development of biodegradable microcarriers for enhanced tumor imaging and therapy
2. Magnetic nanomotors improve delivery precision and effectiveness
3. International collaboration to refine and advance clinical applications, showcasing novel therapeutic strategies

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3. A. Jaiswar, et al., "Optical imaging of up-conversion nanoparticles attached magnetic nano-swimmers through tissue-mimicking phantoms," IEEE ICEE (2022) 1-4

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