

Scalable fabrication of monodisperse microparticles using in-air microfluidics

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Microparticles in biomedical applications

- Controlled released
- Stabilization
- Solubilization
- Taste masking
- Reduction of toxicity
- Improve efficacy

Applications examples



Biopharmaceuticals



Wound healing



Tissue Engineering



API



Vaccine Development



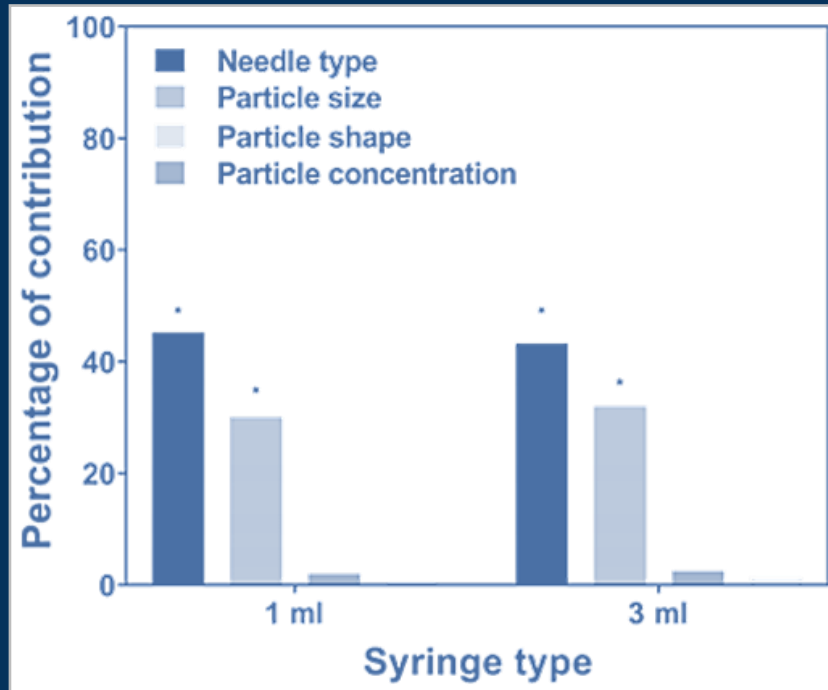
Nutraceuticals

Delivery Formats



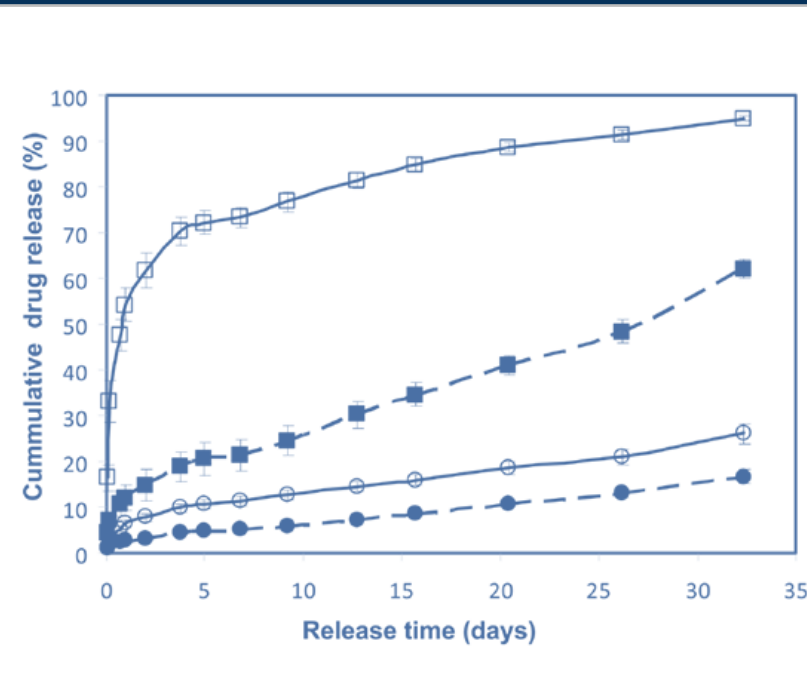
Importance of Monodispersity

Injectability & Flowability

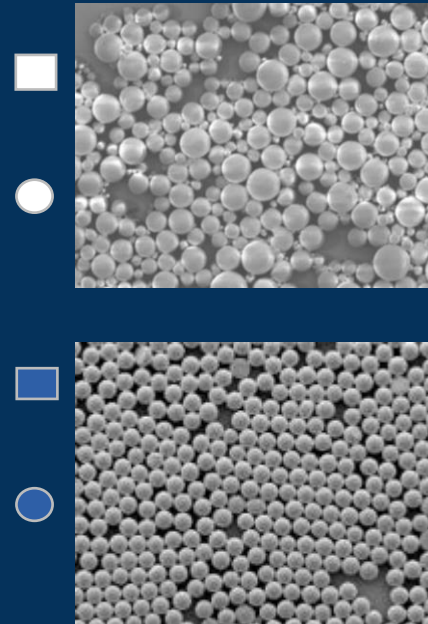


Langer and co-workers, *Science Advances* 2020(6), eabb6594

Controlled Release

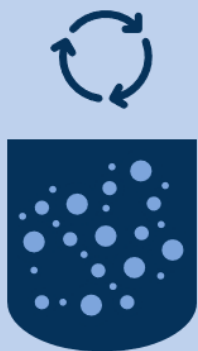


Qiaobing Xu, *Small*, 2009; 5(13): 1575-1581



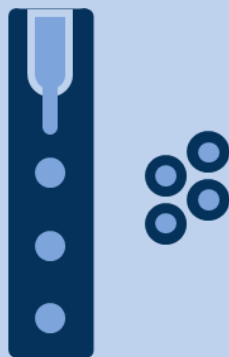
Revolutionizing microparticle production

TRADITIONAL BULK FABRICATION



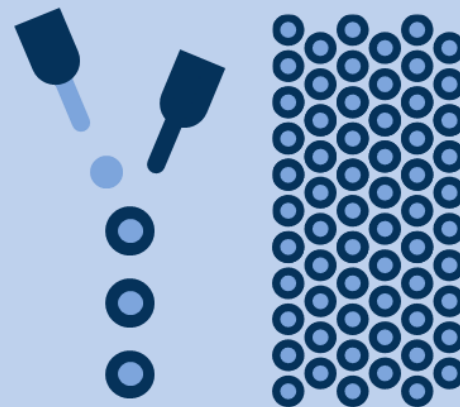
- Low quality
- + High quantity

CONVENTIONAL CHIP-BASED MICROFLUIDICS



- + High quality
- Low quantity

PATENTED IN-AIR MICROFLUIDICS TECHNOLOGY



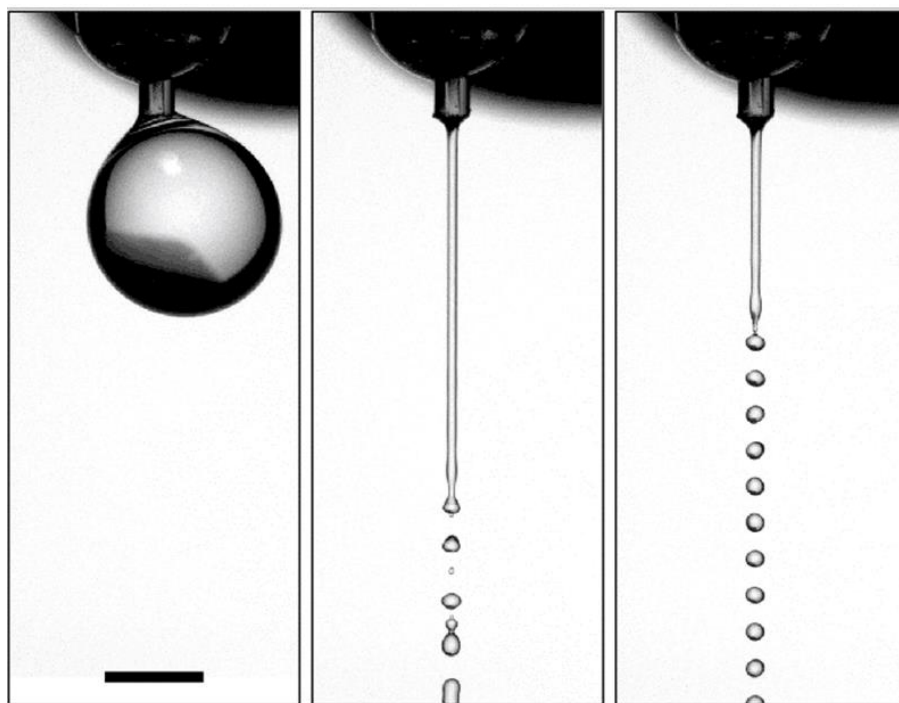
- + High quality
- + High quantity

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In-air microfluidics technology

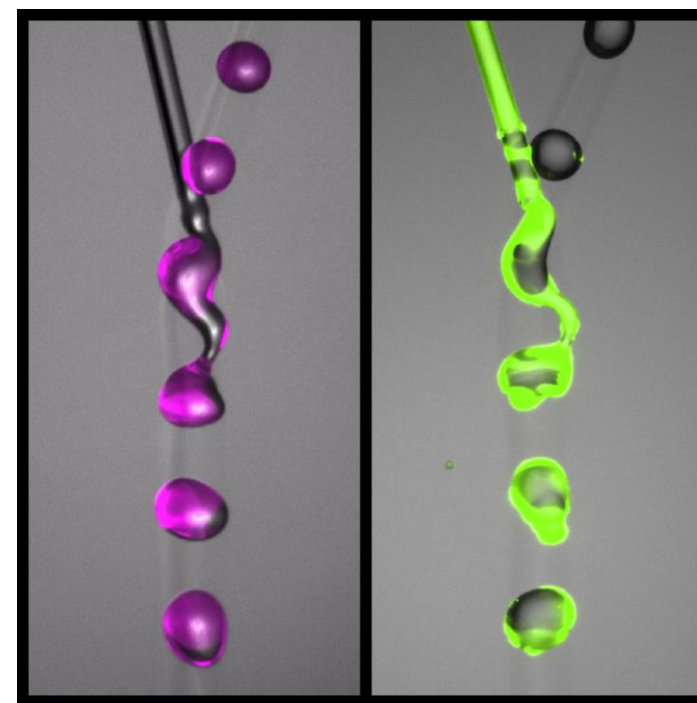
Dripping

Jetting



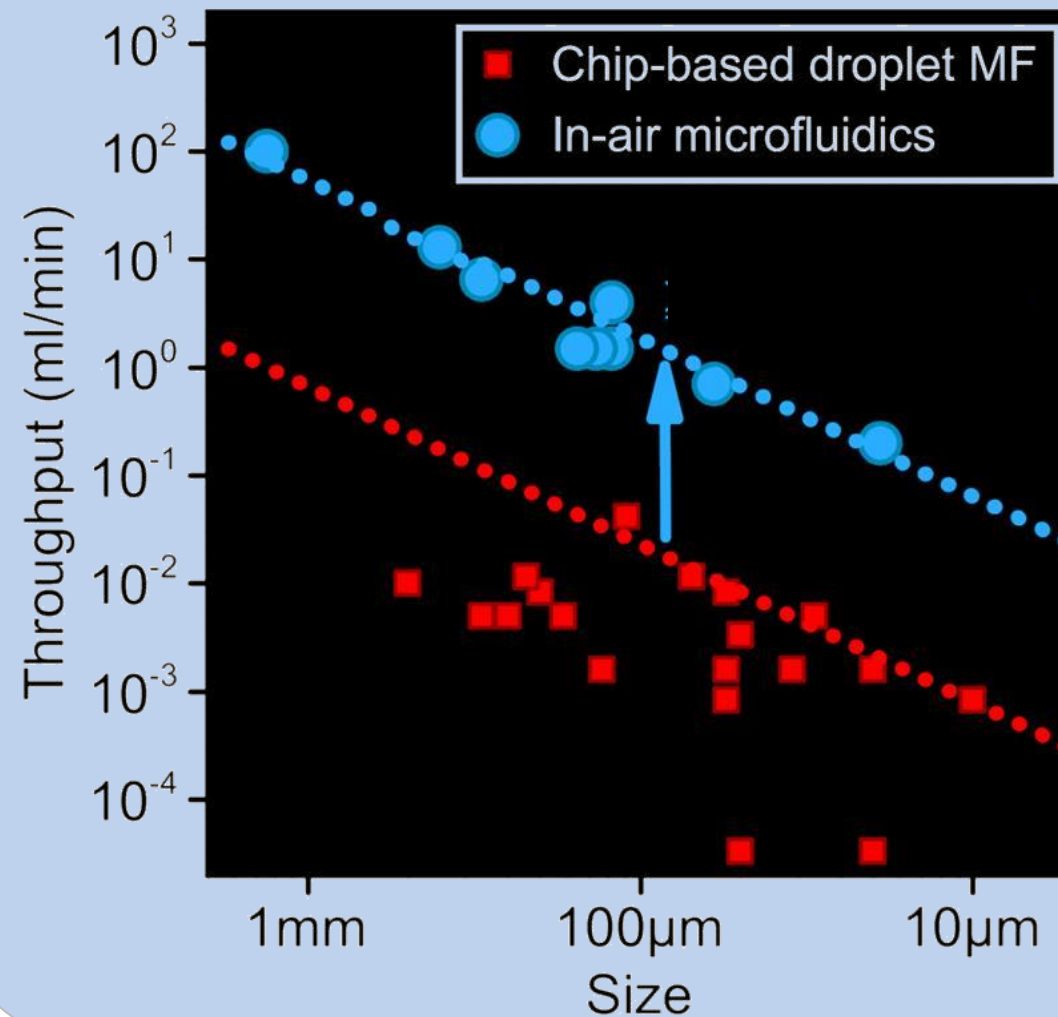
$We_{EJ} > 1$ Nozzle actuation

Encapsulation



Accurate & Fast

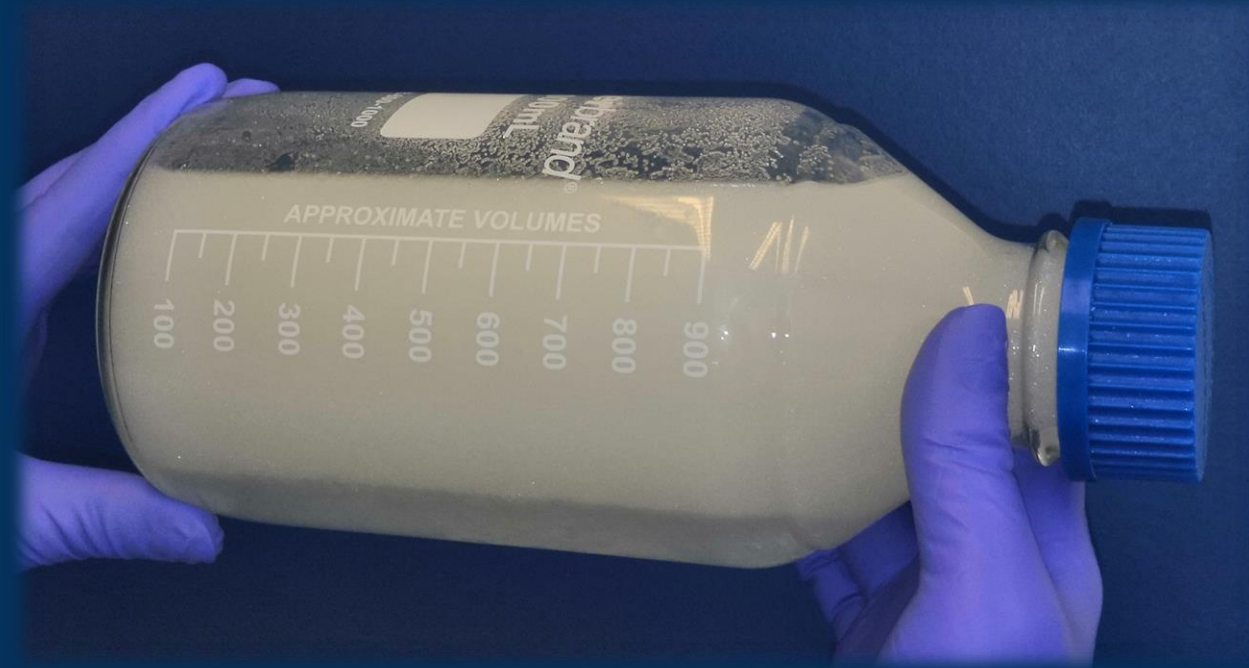
- 1000x faster than chip-based microfluidics
- Chip-free
- Speed (ml/min)
- In-air crosslinking
- Monodisperse CV < 10%
- In-line control



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Scalable & Sustainable

- Continuous microfluidic process
- R&D & pre-clinical (g/day)
- Clinically & commercially scalable (kg/day)
- Less toxic solvents (Class 3)
- Minimal waste

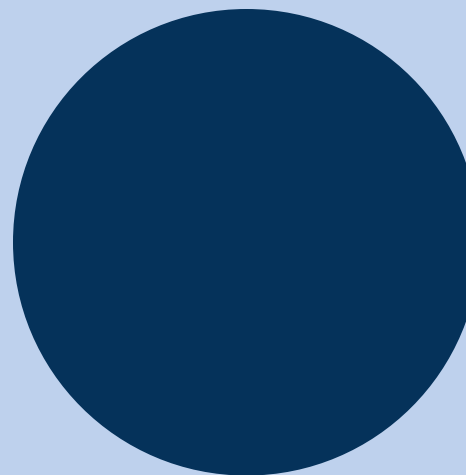


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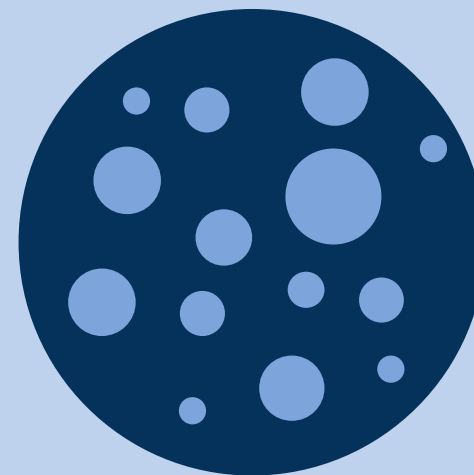
Structure versatility

- Active pharmaceutical ingredients
- Peptides
- Nucleotides
- Proteins

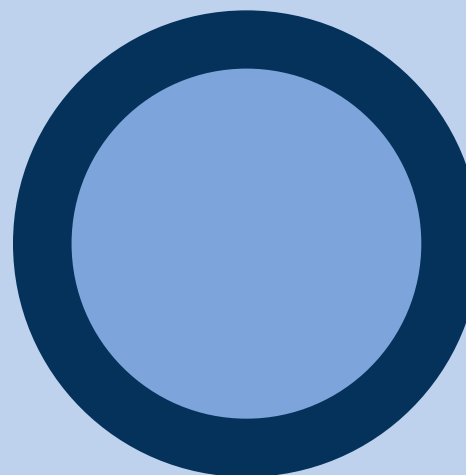
Simple matrix



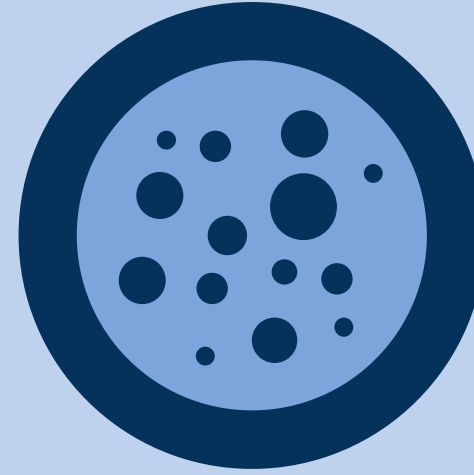
Emulsion



Core-shell

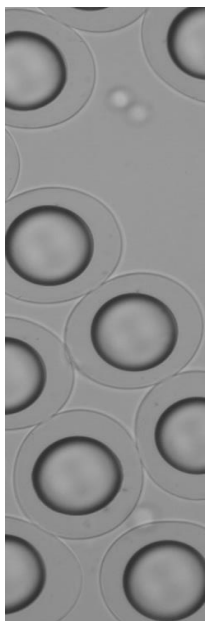


Complex



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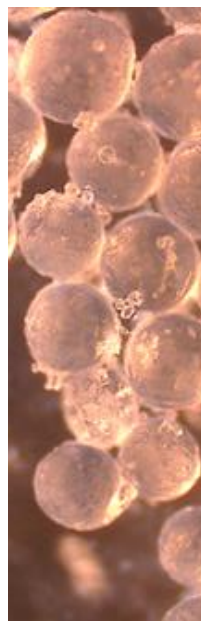
Material versatility



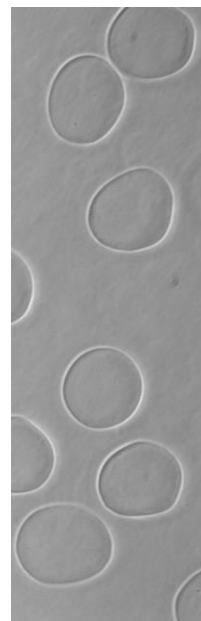
Lipids



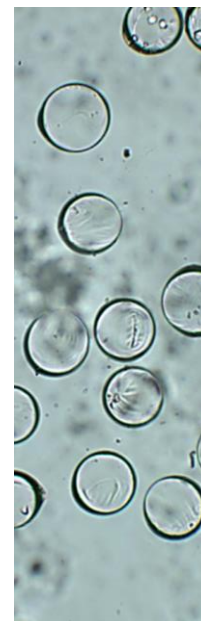
Polysaccharides



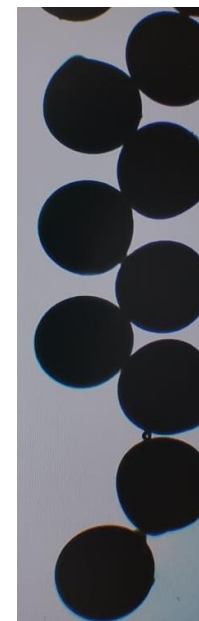
**Pickering
emulsions**



Gelatin

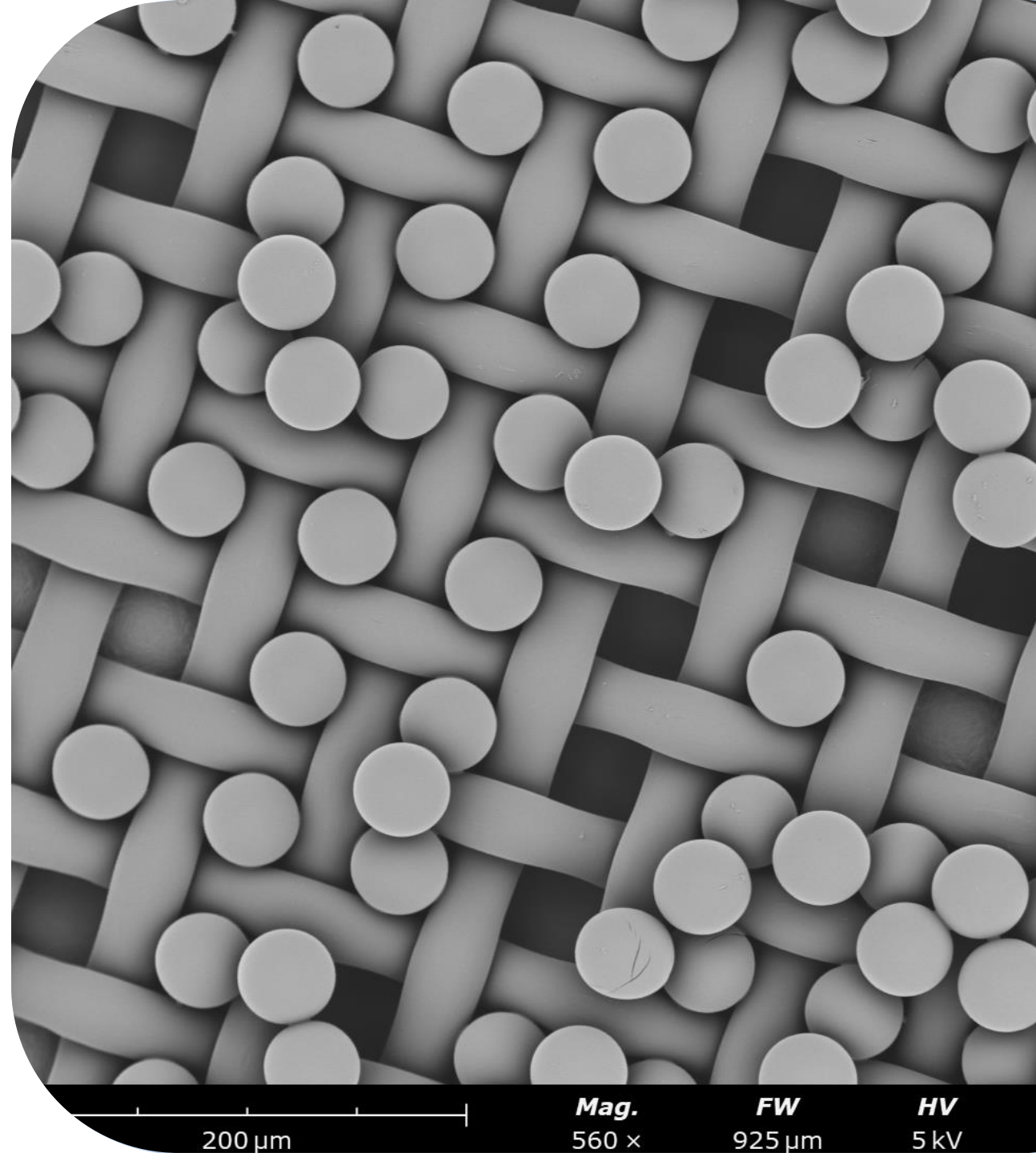
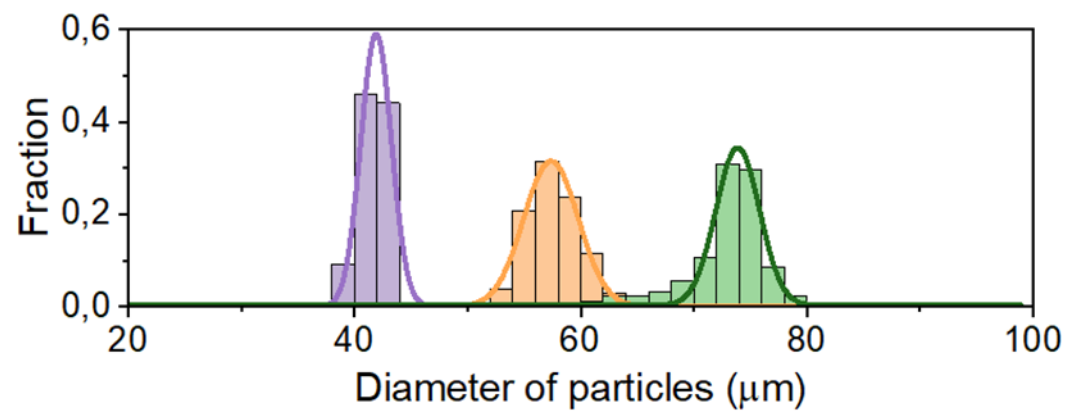


PMMA



PLA

PLGA microparticles



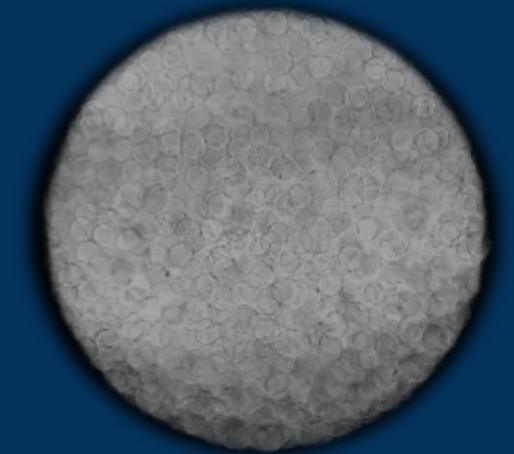
Microencapsulated curcumin

- Microparticles size $73 \pm 5 \mu\text{m}$
- Stable encapsulation (> 3 weeks)
- Encapsulation efficiency of $\geq 40\%$
- Free-flowing powder



Conclusions

- Unique platform technology
- Injectability and flowability
- Superb: tuneable size and low size distribution
- Sustainable: Solvents class 3
- Scalable: g to kg/day
- Material compatibility
- Encapsulation and stabilization of actives



Thanks!

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