IamFluidics
revolutionize microparticles

Full control over every particle property, at every scale

Tunable and uniform microparticles for long-acting injectables of sensitive APIs such as peptides and biologics

The release profile of a microparticle depot depends on its size, structure and composition. Most processes cannot produce well-defined particles due to process fluctuations and gradients, especially when scaling. IN-AIR MICROFLUIDICS™ makes every particle the same way, from the first gram to the scale your therapy needs.[1]

TECHNOLOGY COMPARISON

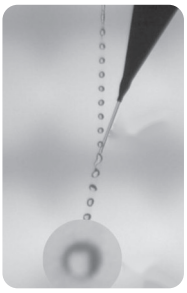
Traditional particle manufacturing approaches have limited control over particle properties, use harsh formulations or processes, or are not scalable. IN-AIR MICROFLUIDICS™ uniquely enables control, biocompatibility and scale.

IN-AIR MICROFLUIDICS™ is	more uniform than **Emulsion** homogenization	more flexible than **Membrane** emulsification	more scalable than **Microfluidic** chips	more gentle than **Spray** drying	**IN-AIR MICROFLUIDICS™**
Size uniformity	○○	●●	●●	○○	●●
Throughput & scalability	●●	●●	○○	●●	●●
Core–shell architecture	○○	○○	●●	●○	●●
Morphology control	●○	●○	●○	●○	●●
Solvent & material flexibility	●○	●○	●○	●○	●●
Gentle processing	○○	●○	●●	○○	●●
Encapsulation efficiency	●○	●○	●●	●○	●●

●● controlled ●○ partly ○○ limited

HOW IT WORKS

With IN-AIR MICROFLUIDICS™, every droplet receives identical treatment, giving fully reproducible solvent extraction and particle formation, also during scale-up.



Scalable & clean
high-throughput jetting

Biocompatible, on-the-fly
encapsulation & reaction

Reproducible, high-quality
microparticles & core–shell capsules

Liquid jets in air (high-speed image).

1 Formulation & process, designed together
Our in-house designed and engineered microfluidic nozzles turn the API–polymer solution into a liquid jet that breaks up into uniform droplets, far faster than chip-based microfluidics and with no channels to clog.

2 High encapsulation efficiency
Droplets meet a second liquid jet and start to solidify on impact. Because every droplet is encapsulated on the fly, encapsulation efficiency is very high and little of the precious biologic is wasted.

3 Morphology by design
The choice of solvents, polymers and formulation sets how fast solvent is extracted from each droplet. Control over solidification from the moment of droplet formation gives control over morphology and release profile.

<100 µm
injectable size range

µm-thin
tunable polymer shells

Low-burst
release profile

>3 months
controlled release*
*In a client case.

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THREE LEVERS OF PARTICLE CONTROL

Nozzle design, flow rate and formulation each set a different particle property.

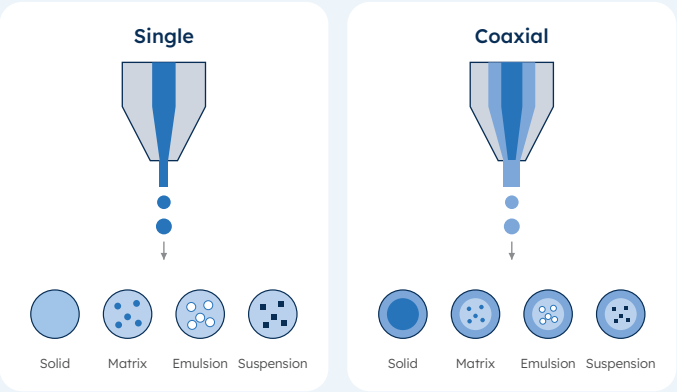
1 NOZZLE DESIGN

The nozzle defines the particle's architecture.

We design and engineer our precision nozzles in-house, around the particle you need:

- **Single nozzles** make matrix particles, with the API dissolved, emulsified or suspended in the polymer solution.
- **Coaxial nozzles** create an API-rich core inside an API-poor polymer shell: an extra barrier against early leakage of the sensitive API.

Solutions, emulsions and suspensions: sensitive APIs such as biologics can be incorporated in the format that suits them best, which most other manufacturing techniques cannot offer.

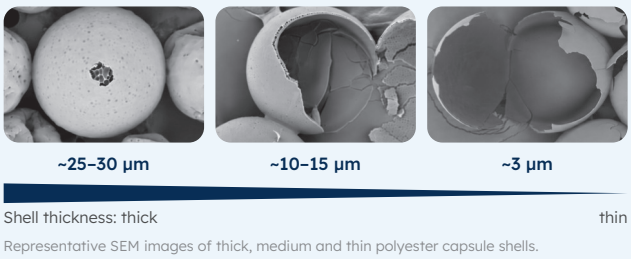


2 FLOW RATE

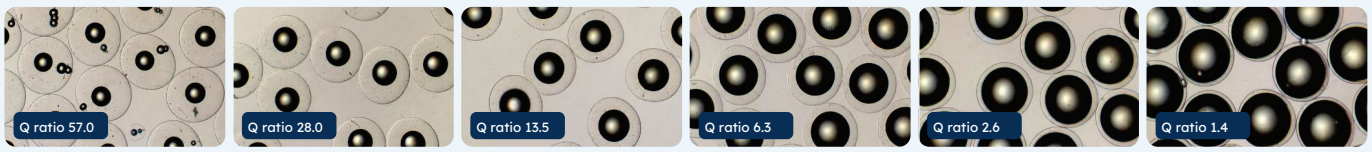
Flow sets particle size and shell thickness.

Jet flow rates and their ratio set the droplet volume, and with it the particle size. In core–shell mode, the shell-to-core flow ratio sets how much polymer surrounds each core. We can readily tune this ratio over a wide range, moving smoothly from thick-shelled capsules to capsules with a large core and a thin shell, with a narrow size distribution (~80 µm, CV < 10%).

Very thin shells: dense polymer shells of ~3 µm and thinner can enclose the core.



Representative SEM images of thick, medium and thin polyester capsule shells.



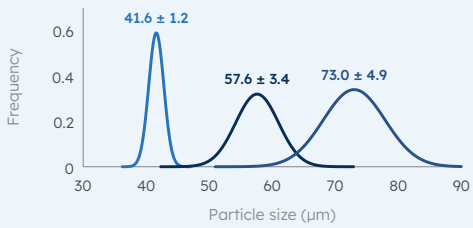
Capsules made at decreasing shell-to-core flow ratio (Q shell / Q core): from thick shell to large core.

3 FORMULATION

Formulation sets how the particle solidifies.

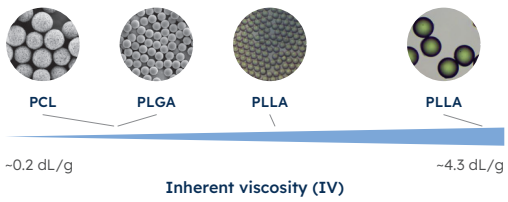
- **Polymer and molecular weight** set degradation rate (e.g. PLGA, PDLLA, PLLA, PCL; other polymers on request).
- **Polymer concentration** in the feed affects morphology and solvent extraction rate.
- **Solvent, cosolvent and antisolvent** set solvent extraction rate and porosity (page 3).

Different sizes, same narrow distribution



Polymer classes

PLGA poly(lactide-co-glycolide)	**PDLLA** poly(D,L-lactide)
PLLA poly(L-lactide)	**PCL** poly(caprolactone)



Commonly used solvents

Ethyl acetate	Anisole
Dichloromethane	and more

Compatible with ICH Class 2 and Class 3 solvents

MORPHOLOGY BY DESIGN

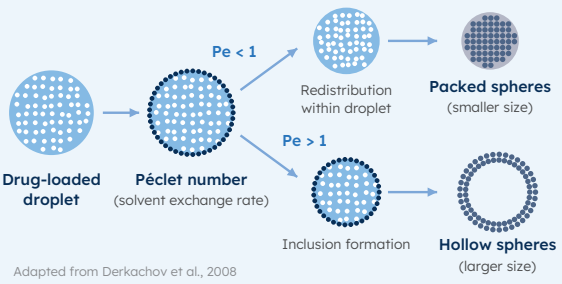
Particle structure, inside and at the surface, has a significant effect on how fast your biologic is released.

Particle structure forms while solvent leaves the droplet. The **Péclet number (Pe)** compares how fast the solvent is extracted with how fast the polymer can redistribute inside the droplet.[2]

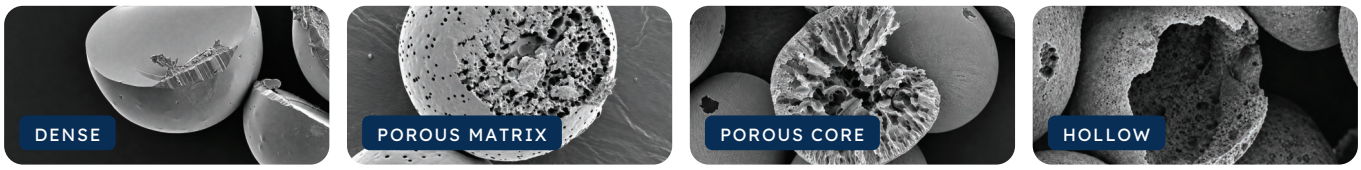
Slow solvent extraction (low Pe): the polymer has time to redistribute evenly, giving a dense matrix particle.

Fast solvent extraction (high Pe): a polymer skin forms first, giving a core–shell-like structure with a porous or hollow interior.

Solvent, cosolvent, antisolvent, polymer concentration and nozzle choice together affect Pe: from dense, through porous matrix and porous core, to hollow and core–shell. By controlling each parameter, we can tune the release behaviour of the biologic of interest.



Adapted from Derkachov et al., 2008



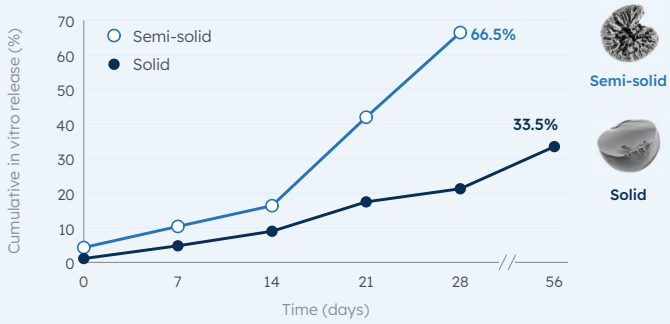
Increasing solvent extraction rate (Pe) and porosity. Biodegradable polymer microparticles made with different solvent systems (SEM).

EVIDENCE 1: TUNING THE RELEASE PROFILE

Same polymer, different structure, different in vitro release profile.

A hydrophobic small molecule was encapsulated in PLGA matrix particles with two morphologies.

- **Semi-solid:** 66.5% released by day 28.
- **Solid:** 21.3% by day 28 and 33.5% by day 56.
- **Low burst release:** 4.3% and 1.1% within 24 h.
- **Activity:** 85% of the encapsulated API still active after 4 weeks.

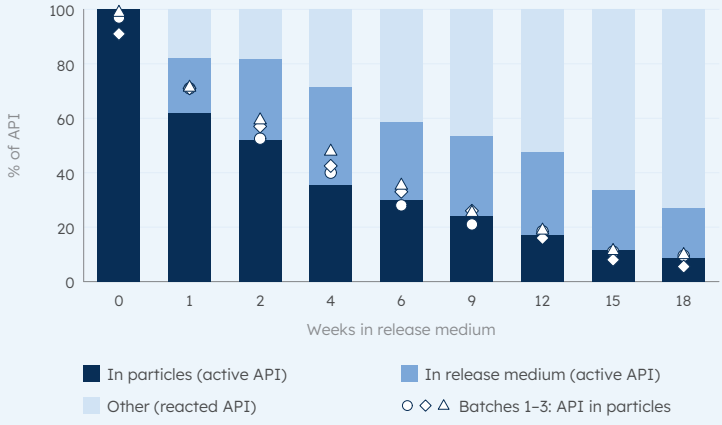


EVIDENCE 2: CLIENT CASE, LONG-ACTING RELEASE

Developed with a client: preservation and controlled release of a sensitive payload for more than 3 months.

- **Low initial burst:** gradual release from day one.
- **Sustained, controlled release:** over 18 weeks.
- **Reproducible:** low variation between 3 independent batches.
- **Active API released:** measured at every time point of the study.

API distribution during in vitro release



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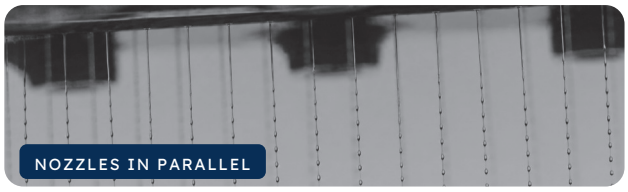
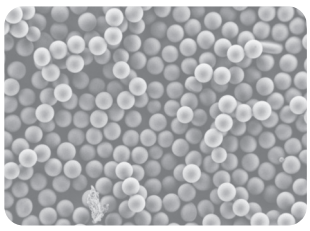
PREDICTABLE SCALING

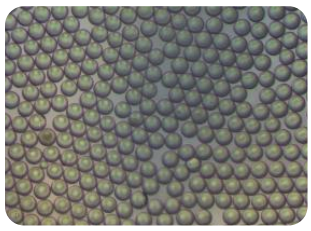
We don't scale by making a bigger process. We scale by adding more identical nozzles.

Batch processes change when they are scaled: concentration, shear and temperature fluctuations and gradients all shift, and so do the particles. IN-AIR MICROFLUIDICS™ is a continuous, high-throughput microfluidic process in which each droplet is processed in an identical manner. Scale-up is achieved by reproducible liquid jet parallelization, preventing traditional scaling issues such as hazardous or uncontrolled gradients.

- **Same control:** size, shell and morphology settings transfer directly.
- **Predictable outcome:** lower risk that development results change at pilot or commercial scale.



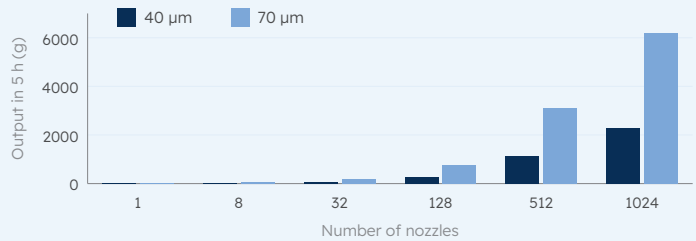




Uniform microparticles: parallel-nozzle batch (SEM, left) and PLLA particles (light microscopy, right).

PROJECTED OUTPUT

Based on single-nozzle throughput, output grows linearly with the number of nozzles.



HOW SCALING WORKS

- **Same nozzle design:** every nozzle is identical to the one used in development.
- **More nozzles, more output:** throughput scales with the number of nozzles.
- **No process redesign:** from grams in feasibility work to kilograms, with the same settings.

ONE PLATFORM, FROM LAB TO PRODUCTION



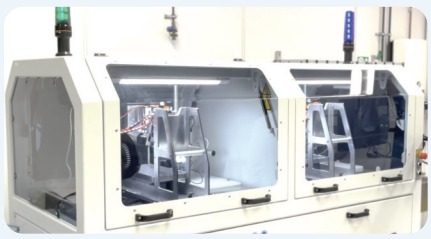
IamOne™

Benchtop R&D



Mithra™

R&D and production



Atlas™

Production

MINIMAL BIOLOGIC NEEDED TO START

High encapsulation efficiency and little process waste mean feasibility work can start with small quantities of biologic, lowering the cost and risk of the first screening.

References: 1 Visser CW, Kamperman T, Karbaat LP, Lohse D, Karperien M. In-air microfluidics enables rapid fabrication of emulsions, suspensions, and 3D modular (bio)materials. Sci Adv 2018;4:eaao1175. 2 Wei Y, et al. Int J Heat Mass Transfer 2016;97. Morphology diagram adapted from Derkachov et al., 2008. Model API and client-case data: IamFluidics.

START WITH A FEASIBILITY STUDY

Tell us about your biologic of interest.

1 Intake	2 Screening	3 Samples	4 Report
molecule, dose, duration	route & morphology	size, loading, EE, activity	release & scale-up plan

Request your feasibility study: info@iamfluidics.com

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