

Master Thesis Project:

Information Encoding with Droplet Polymers

Supervisor: dr. Martin F. Haase, m.f.haase@uu.nl, www.martinhaase.com

Van't Hoff Laboratory for Physical and Colloid Chemistry

Nature ingeniously encodes information through the sequence of base pairs in DNA, guiding the assembly of proteins. In contrast, **synthetic copolymers** lack such control, as co-monomers are distributed randomly along the chain. To overcome this limitation, recent research with emulsions has introduced **droplet polymers with programmable sequences** for microscopic information encoding. However, the underlying chemistry is often complex and difficult to scale, restricting practical applications.

The goal of this MSc project is to explore a **simple yet powerful approach** to obtain droplet polymers with encoded information. Using **microfluidics**, we generate monodisperse droplets in which nanoparticles self-assemble at the droplet surfaces (Figure 1). These nanoparticles link adjacent droplets into chains, while **fluorescent dyes** incorporated into each droplet provide a programmable binary code. This strategy offers a scalable pathway to create droplet polymers with potential applications in **information storage and encryption technologies**.

As part of this project, the MSc student will:

- Gain theoretical and experimental expertise in **nanoparticle-stabilized emulsions**, **microfluidic flow dynamics**, and **droplet stabilization**.
- Learn how to **surface-functionalize nanoparticles** with surfactants and study their diffusion-driven behavior.
- Design, assemble, and operate **microfluidic devices** for droplet polymer production.
- Use **high-speed imaging (tens of thousands of frames per second)** and **optical/fluorescence microscopy** to characterize droplet formation and polymer chains.

This project offers an exciting opportunity to combine **fundamental colloid and interface science** with the emerging field of **information-encoding materials**.

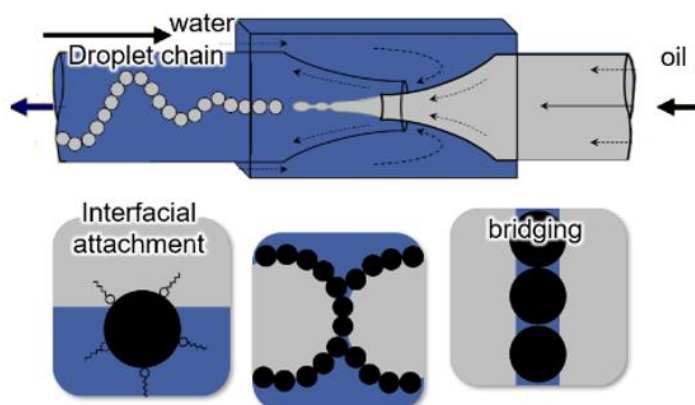


Figure 1. Microfluidic approach to generate droplet polymers and interfacial particle attachment and bridging mechanism.