

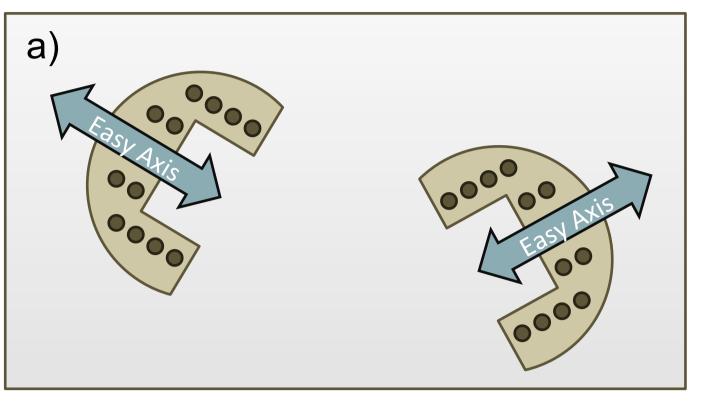


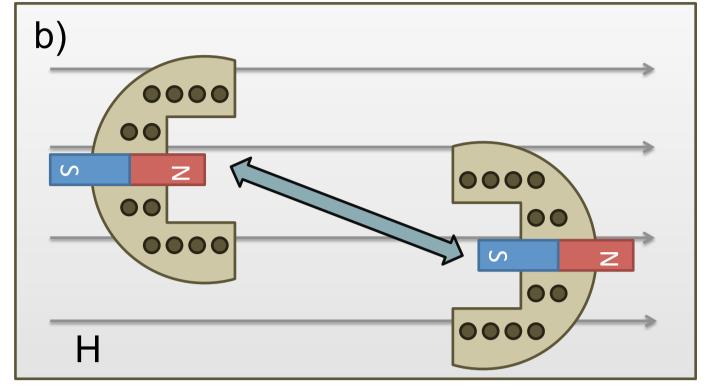
# Magnetically Guided Self-Assembly

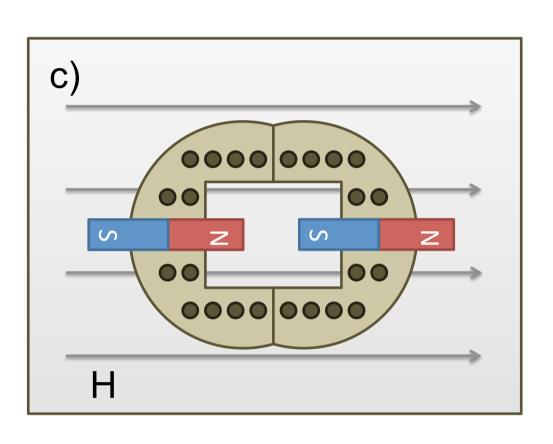
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#### Magnetic Guiding

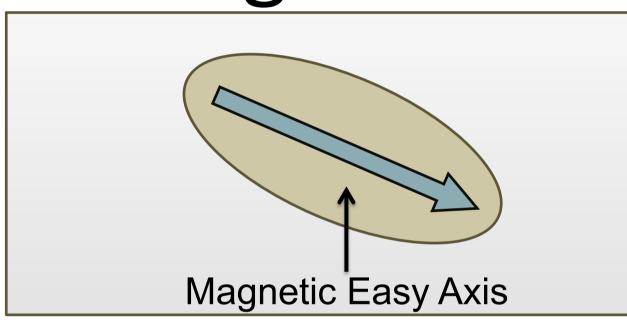


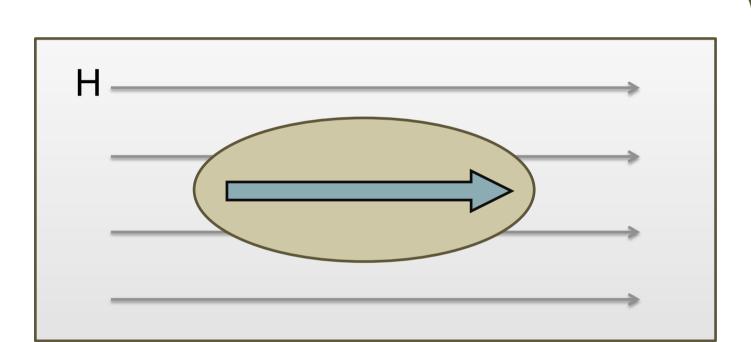




- a) Half capsules with magnetic nanoparticles. The easy axis is defined by aligned nanoparticles.
- b) Parts align with an applied magnetic field.
- c) Building blocks attract each other and align for self-assembly.

## Background

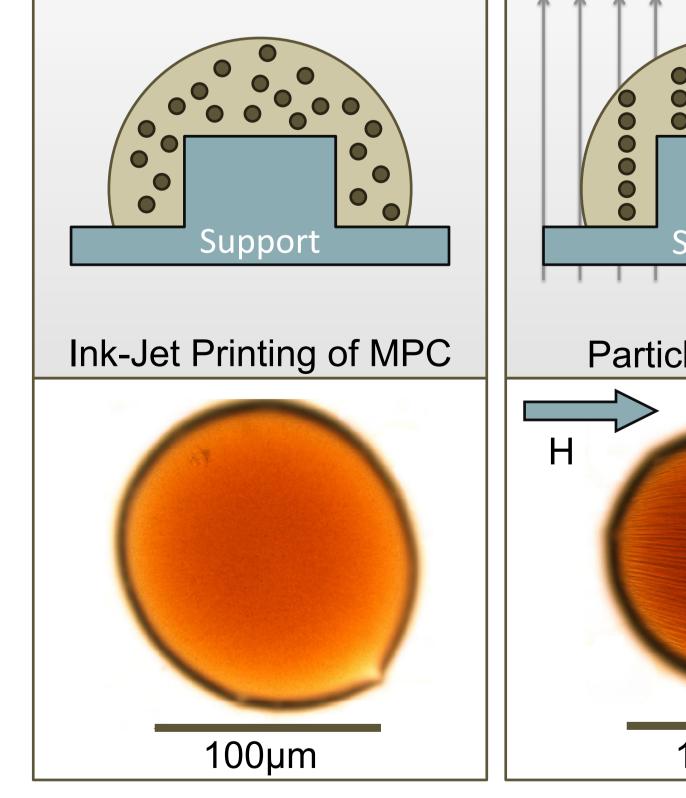


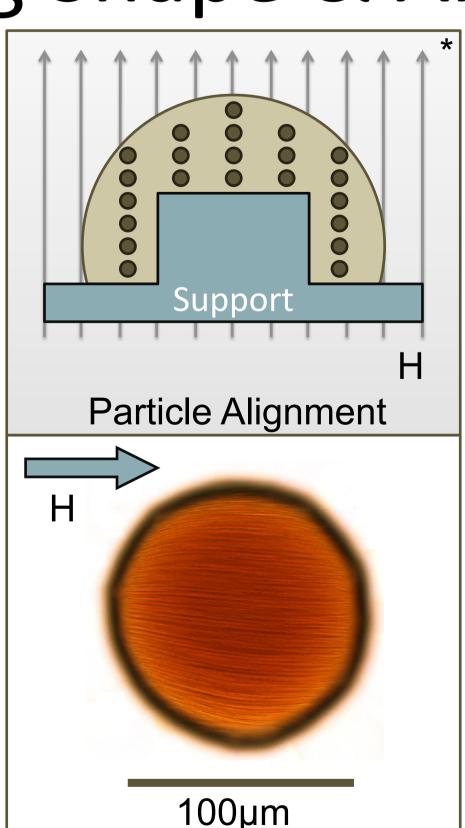


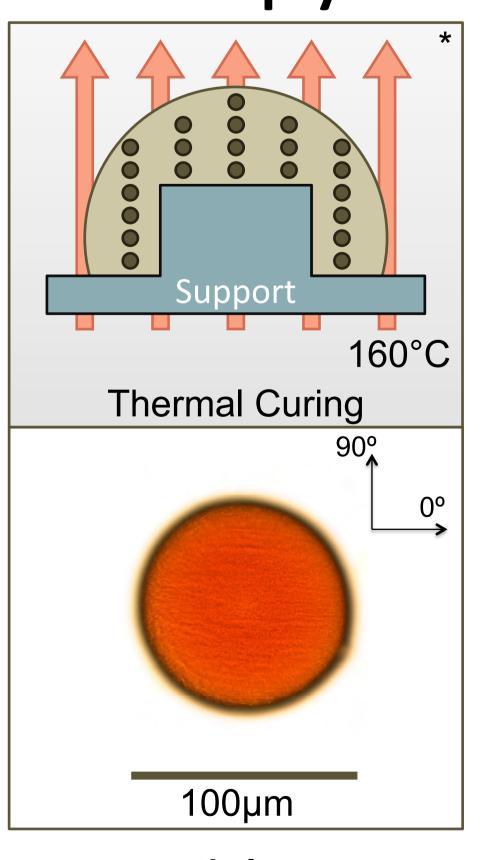
#### Magnetic Anisotropy

- Refers to orientation-dependent magnetic properties
- Implies so-called easy axis along which a soft magnetic body aligns when subjected to an applied magnetic field
- For polymer composites (developed within SelfSys framework, [1]), anisotropy is solely related to shape

## Decoupling Shape & Anisotropy



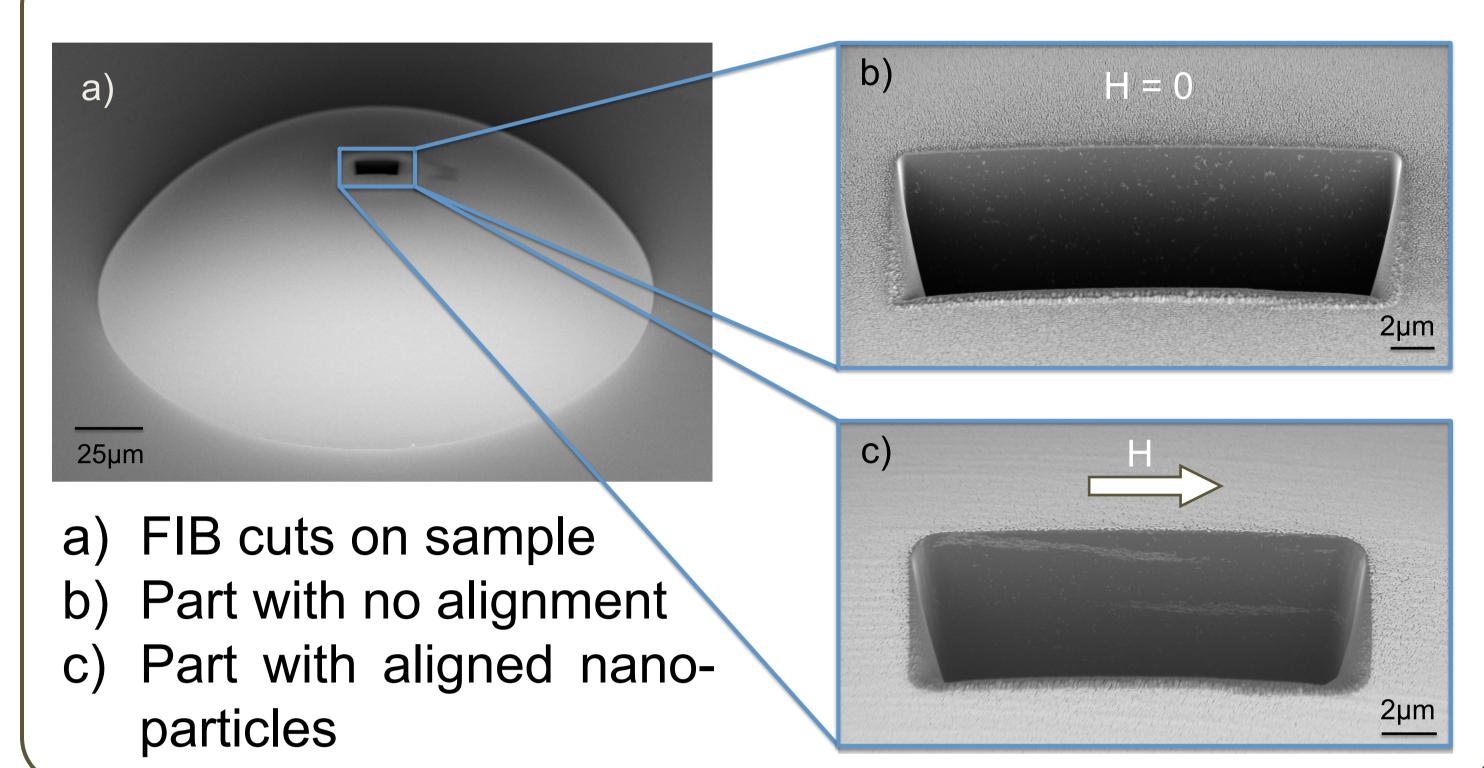




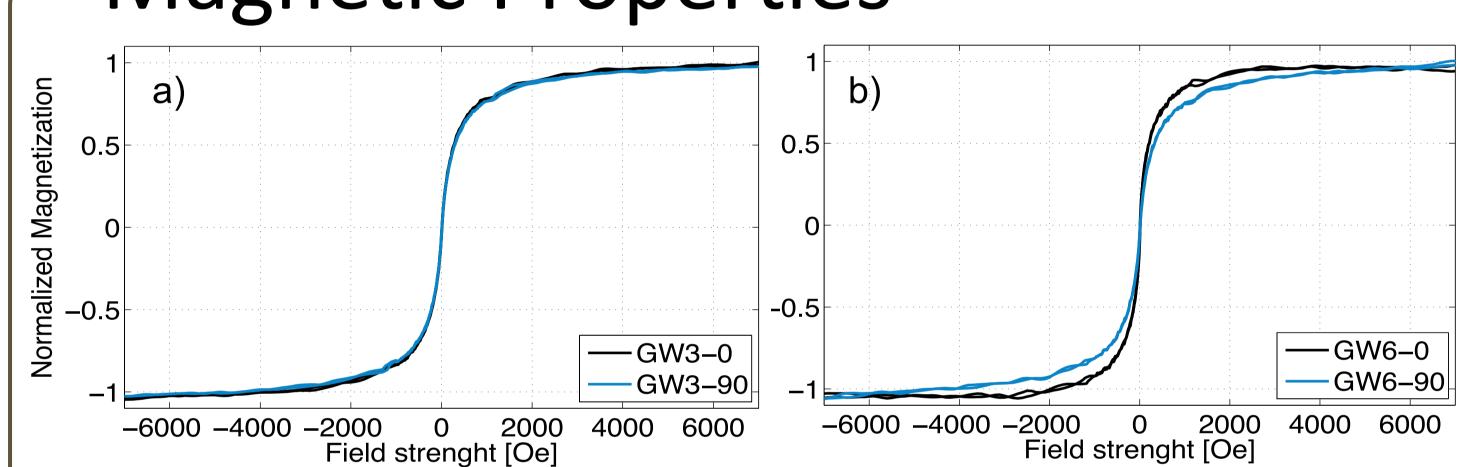
- Inkjet printing of superparamagnetic nanoparticles embedded in uncured polymer matrix
- Alignment of nanoparticles by applying magnetic fields
- Thermal curing for fabrication of features beyond exposable resist thickness [1]

\* The alignment direction is shown as out-of-plane for illustration purposes unlike the photos below

#### Characterization

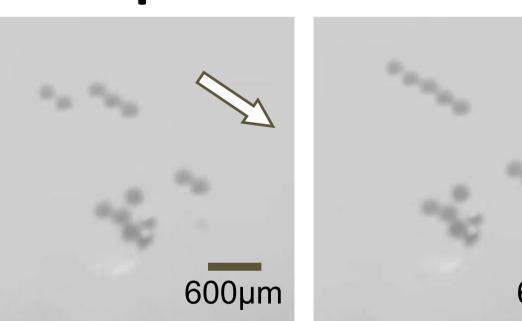


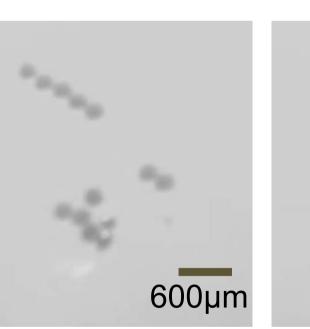
## Magnetic Properties

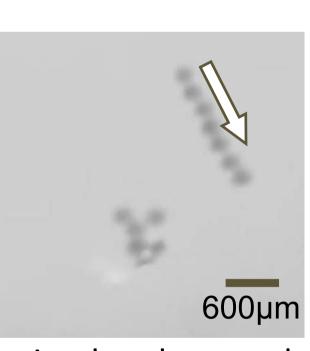


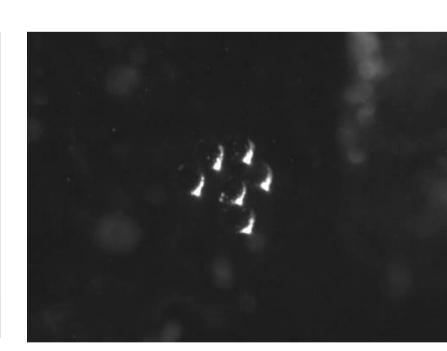
- a) Same magnetic characteristics for the non-aligned parts in any direction
- b) Slope changes along different directions in aligned parts

## Experimental









**⊙**H

Parts can be aligned and chains can be obtained and steered by applying in-plane magnetic fields

Manipulation of ink-jet printed half-capsules, arrows indicate direction of the applied field, H. Chains of parts can be obtained (above) or the parts can be separated and the distance between them can be controlled (right).

Distance between parts can be adjusted applying

out-of-plane H fields

#### Conclusion & Outlook

A combination of ink-jet printing, nanoparticle alignment by applying homogenous magnetic fields, and thermal curing allows fabrication of magnetic half capsules. By magnetic manipulation, these parts can be guided for self-assembly.

This work has been carried out in the framework of SelfSys, scientifically evaluated by SNSF as well as financed by the Swiss Confederation and funded by Nano-Tera.ch.

[1] A photopatternable superparamagnetic nanocomposite: Material characterization and fabrication of microstructures M. Suter, O.Ergeneman, J.Zürcher, C.Moitzi, S.Pané, T.Rudin, S.E. Pratsinis, B.J.Nelson, C.Hierold, Sens. Actuators B: Chem., (2011)





