

# Self-assembly of nanoparticles *in-situ* GISAXS study



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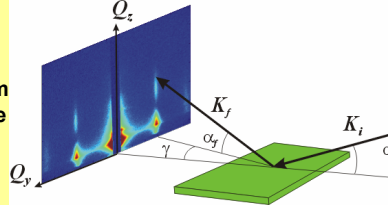
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**Samples:**  
Co nanoparticles ~5.5 nm radius  
Sterically stabilized  
Dispersed in Toluene  
**Preparation:**  
5  $\mu$ l drop deposited on Si<sub>3</sub>N<sub>4</sub> substrate  
Spontaneous and controlled drying  
With and without magnetic field

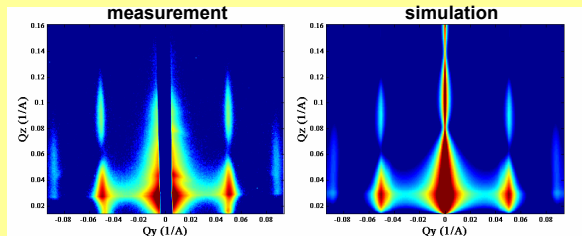
**Experiment:**  
ID10B beamline ESRF  
In-situ GISAXS  
Beam size 0.3(H)x0.05(V) mm  
Acquisition time 5 sec/image  
 $\alpha_i=0.186^\circ$   $\lambda=1.55$  Å  
Princeton CCD



GISAXS  
surface sensitive  
non destructive  
statistically average information

$$I(Q) \sim |F(Q)|^2 \cdot S(Q)$$

Form factor  $\rightarrow$  Structure factor



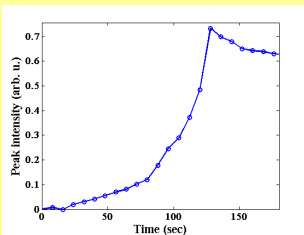
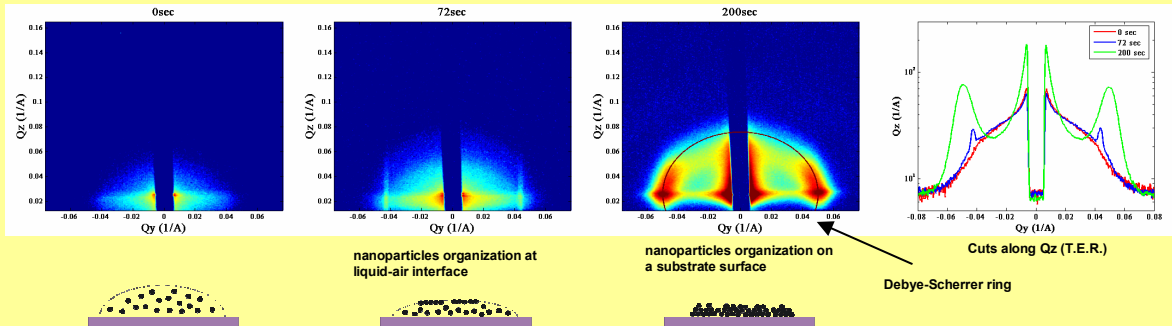
Slow drying of the drop ~20 min  
Perpendicular magnetic field B=0.4 T

R=5.4 nm r.m.s.=0.3 nm  
D=14.3 nm r.m.s.=1.2 nm  
2D short-range order with hexagonal symmetry

How does the layer grow?

## In-situ GISAXS

Spontaneous evaporation ~5 min B=0 T



Linear dependency  
particles trapping at the liquid-air interface  
surface diffusion and 2D islands growth

Peak Intensity =  $S(Q) - 1$   
Proportional to ordered area  
 $S(Q)=1$  for random distribution

“Exponential” dependency  
final stage of a solvent evaporation  
layer corrugation

Growth process  
(Terry P. Bigioni *et. al.* (to be published in Nature Materials))  
Depends on evaporation rate  
Initial particles concentration  
Type of surfactant  
Presence of the magnetic field etc.

## Conclusions and perspectives

- Nanoparticles self-assembly can be successfully studied by *in-situ* GISAXS
- Highly ordered layers are obtained at optimum evaporation rate
- Layer formation occurs a liquid-air interface
- Influence of the magnetic field is to be investigated

## Acknowledgment

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