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Collective rotation of nanorods in thin films

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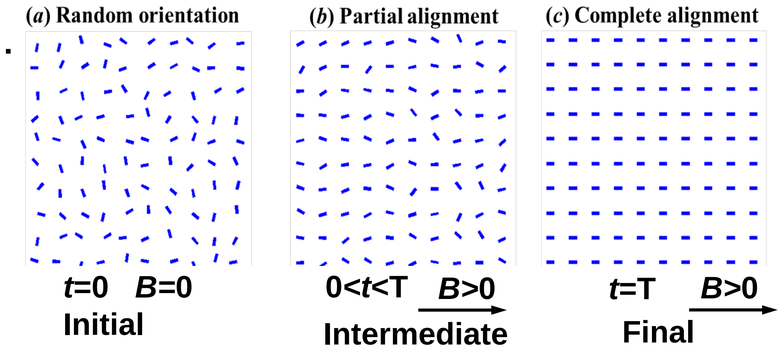
Objective

Fabrication of composites ceramic films containing ordered different structures of magnetic nanorods.

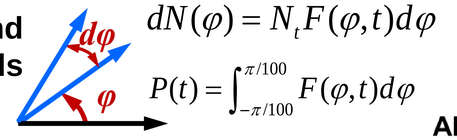


Challenge: Viscosity of the precursor dispersion is time dependent . Not all nanorods can be captured by the field. $\eta = \eta_0 \exp(t/\tau_0)$

Can (*a*) configuration be converted into (*c*)?

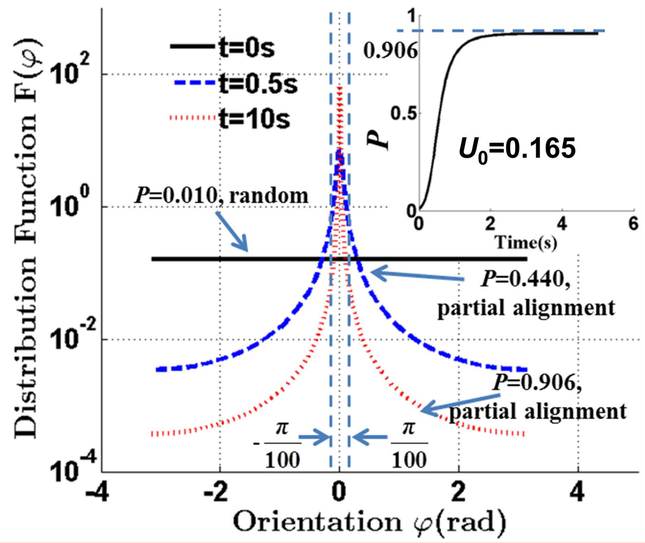
Collective kinetics of nanorods

Distribution function *F* and probability to orient nanorods *P* at time *t*.

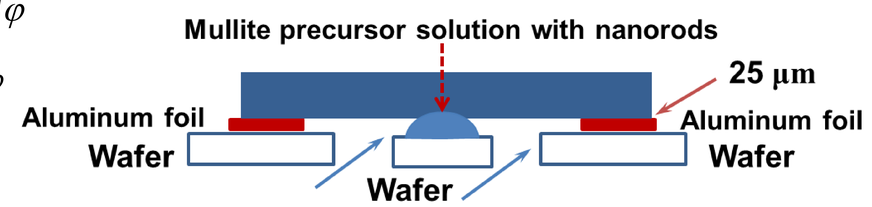


$$dN(\varphi) = N_t F(\varphi,t)d\varphi$$

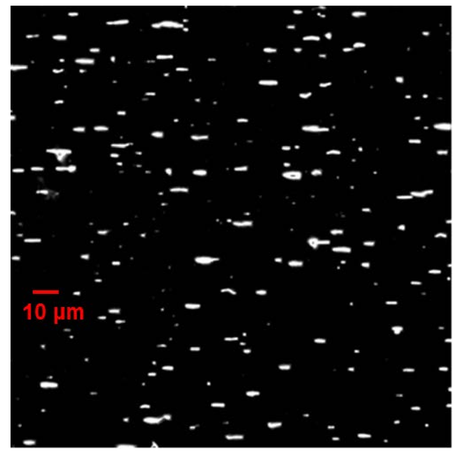
$$P(t) = \int_{-\pi/100}^{\pi/100} F(\varphi,t)d\varphi$$

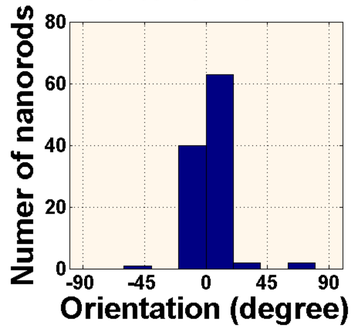


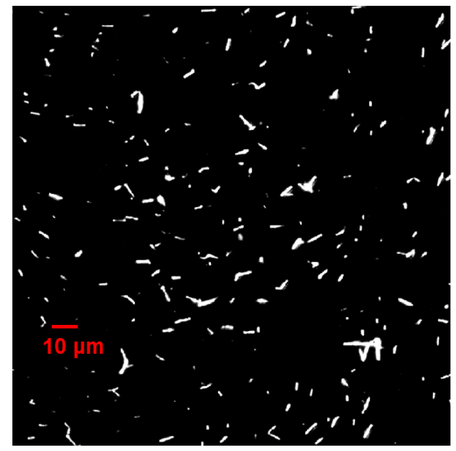
Film formation

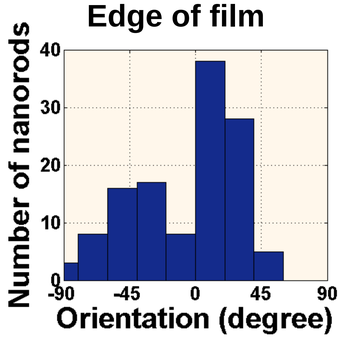


Orientation distribution

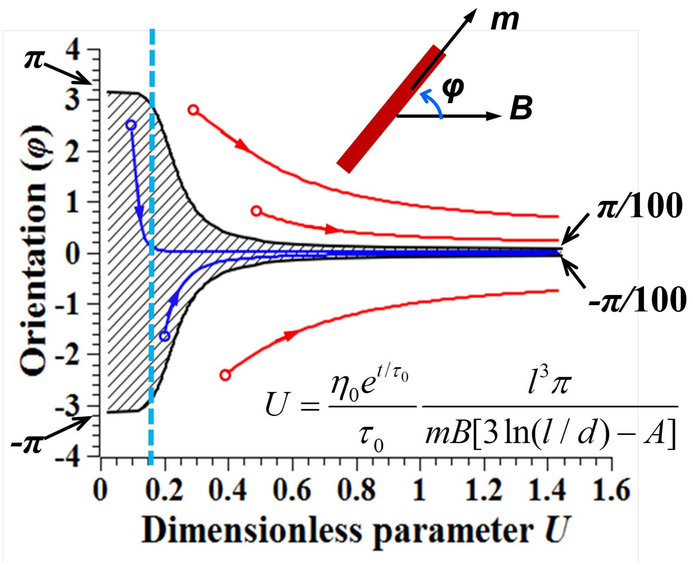








Kinetics of nanorod orientation



$$U = \frac{\eta_0 e^{t/\tau_0}}{\tau_0} \frac{l^3 \pi}{mB[3\ln(l/d) - A]}$$

η_0 : Initial viscosity; B: External magnetic field;

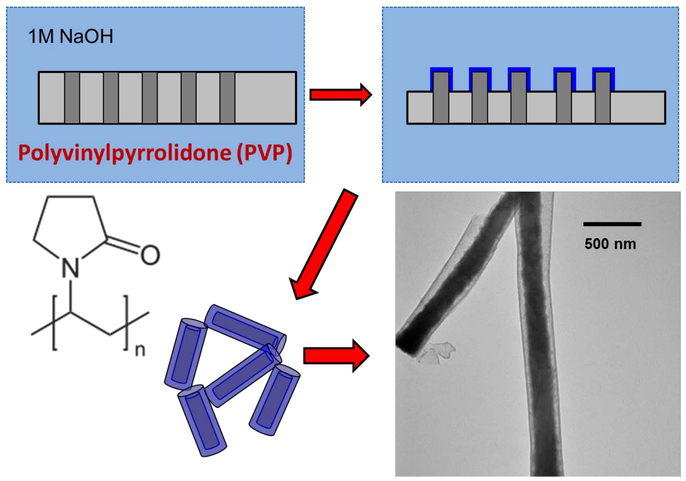
τ_0: Characteristic time of viscosity increase;

d: Diameter of nanorod; l : Length of nanorod;

m : Magnetic moment of nanorod; $A \approx 2.4$

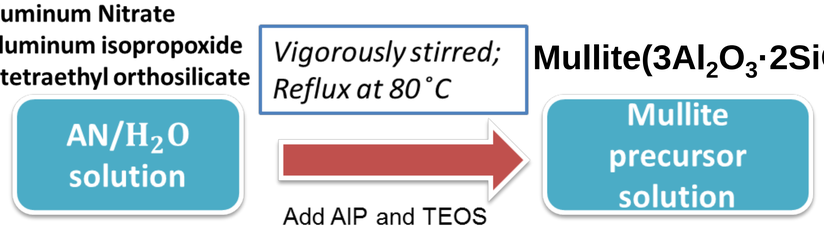
Surface modification of nanorods

wet etching on alumina membrane with rods in presence of PVP (3500 Da)



Film formation

AN: Aluminum Nitrate
AIP: Aluminum isopropoxide
TEOS: tetraethyl orthosilicate



Future work

Analyze the nanorod distribution function and compare with the theory.
Test the property of composite material with ordered nanorods.

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