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# Collective rotation of nanorods in thin films

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# Collective rotation of nanorods in thin films

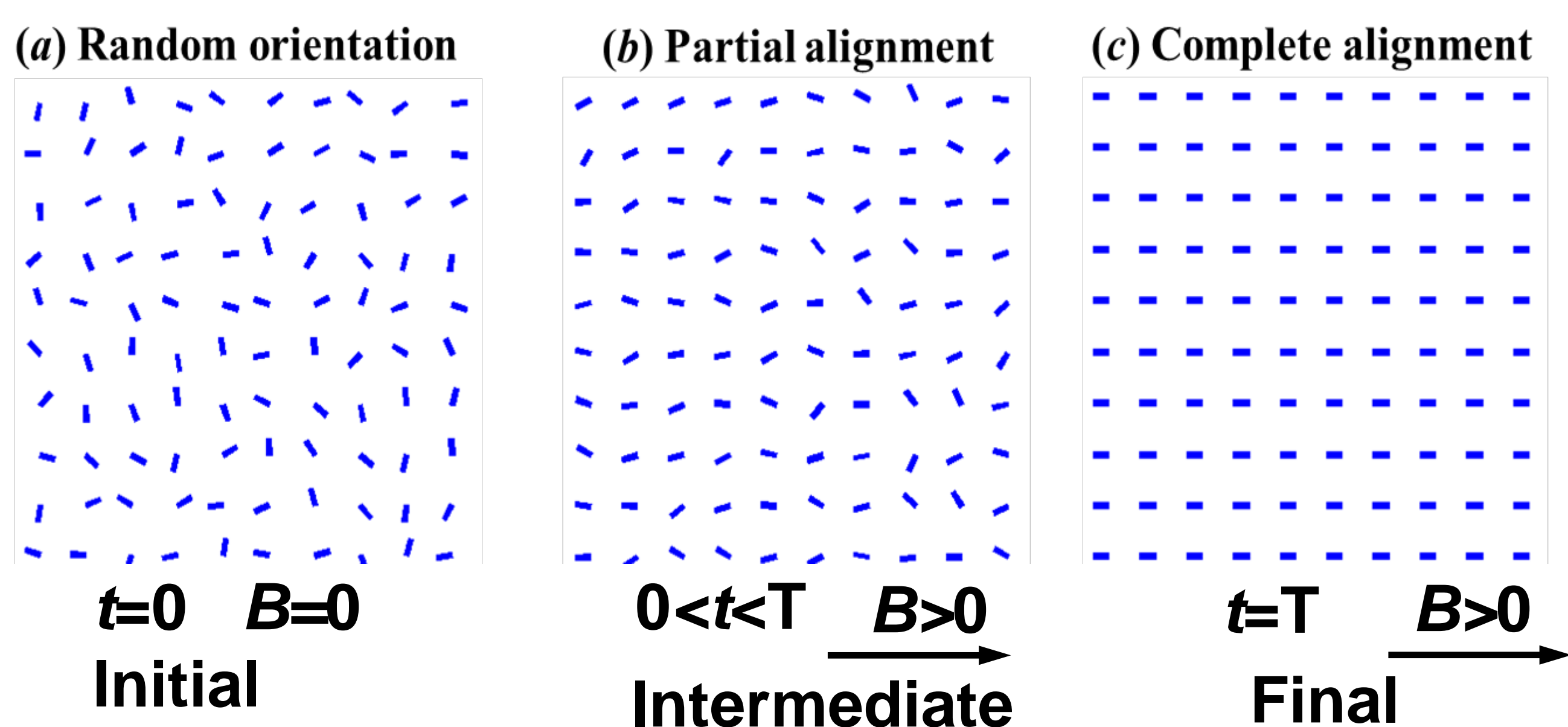
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## Objective

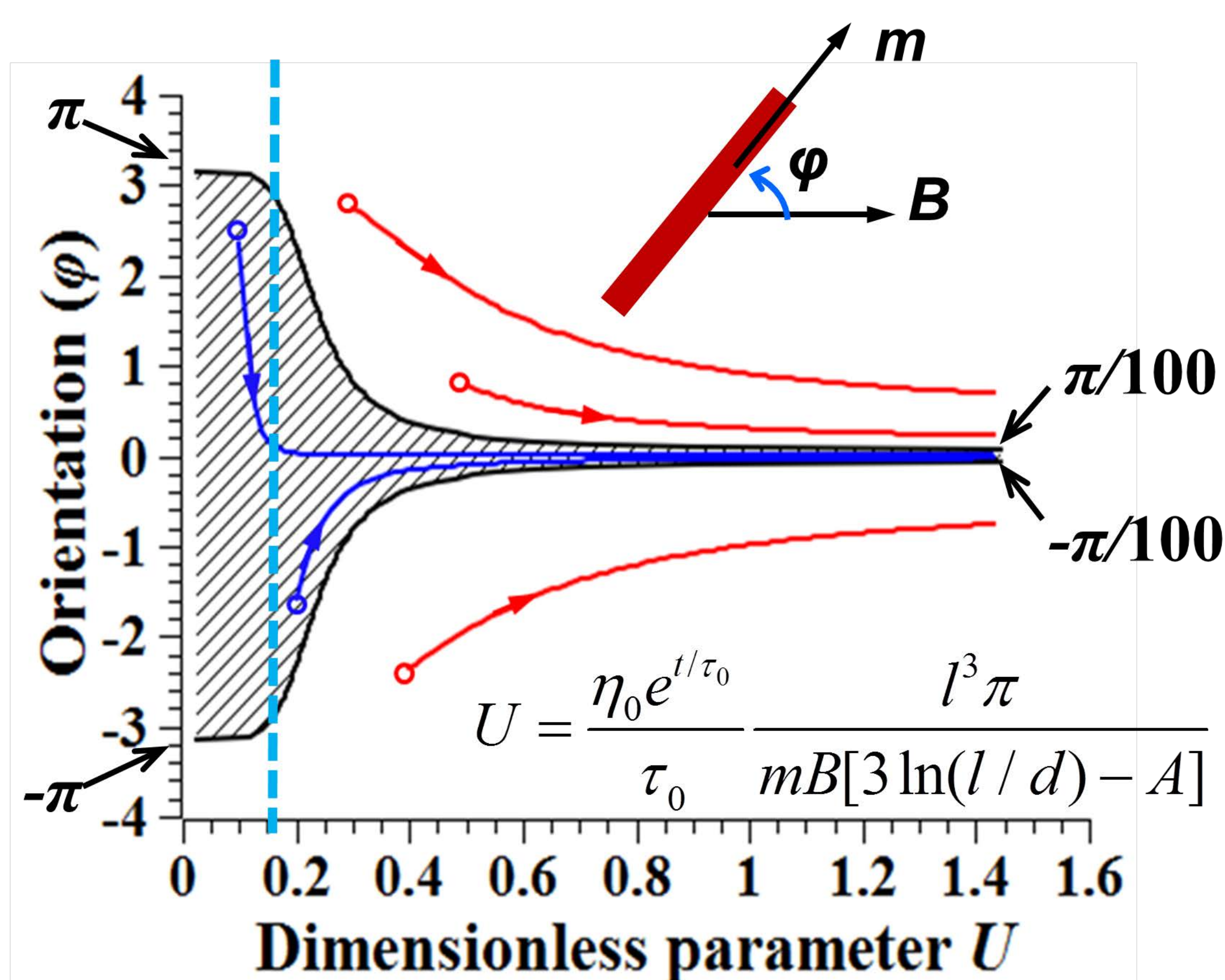
Fabrication of composites ceramic films containing ordered different structures of magnetic nanorods.



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)?

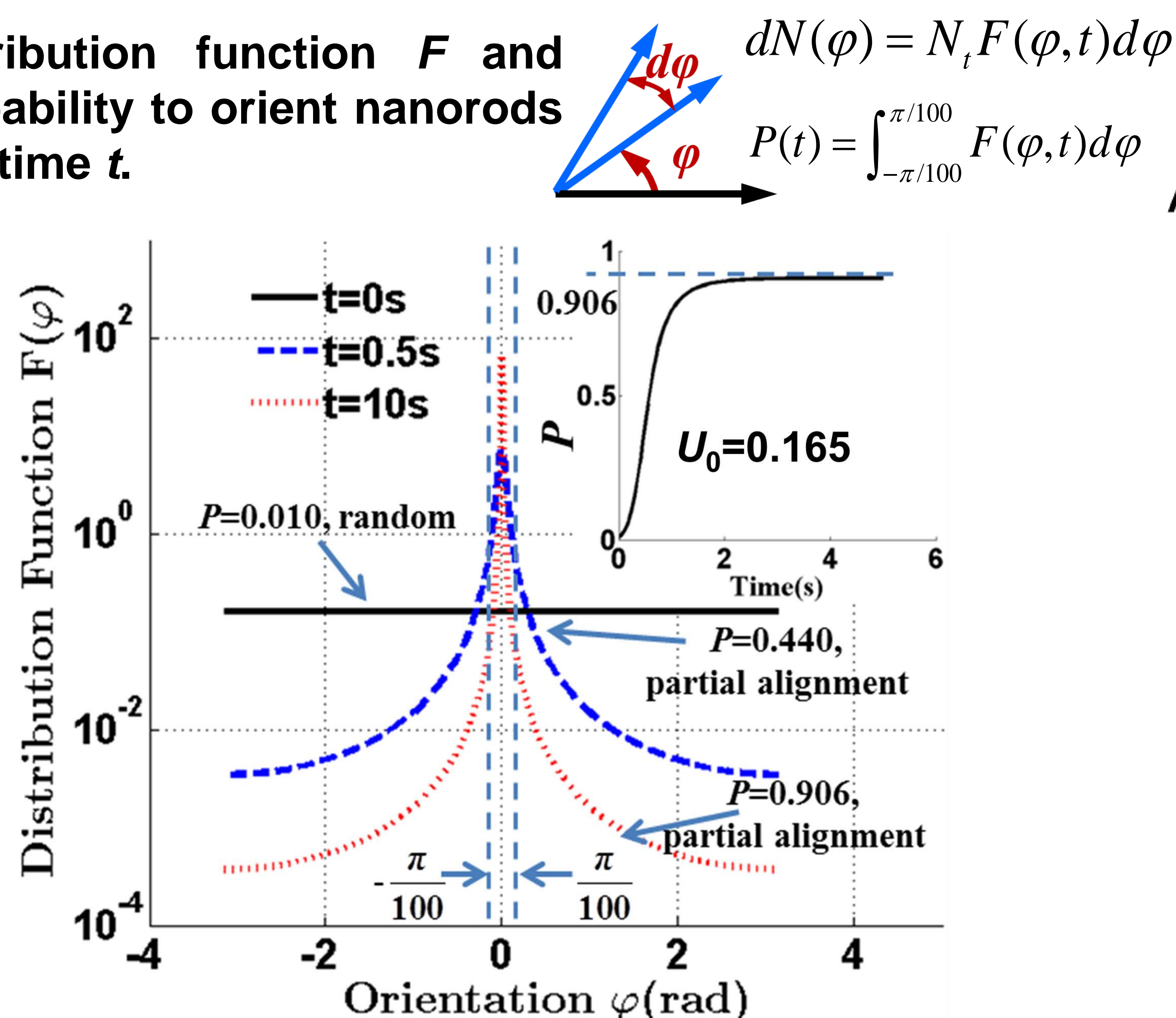
## Kinetics of nanorod orientation



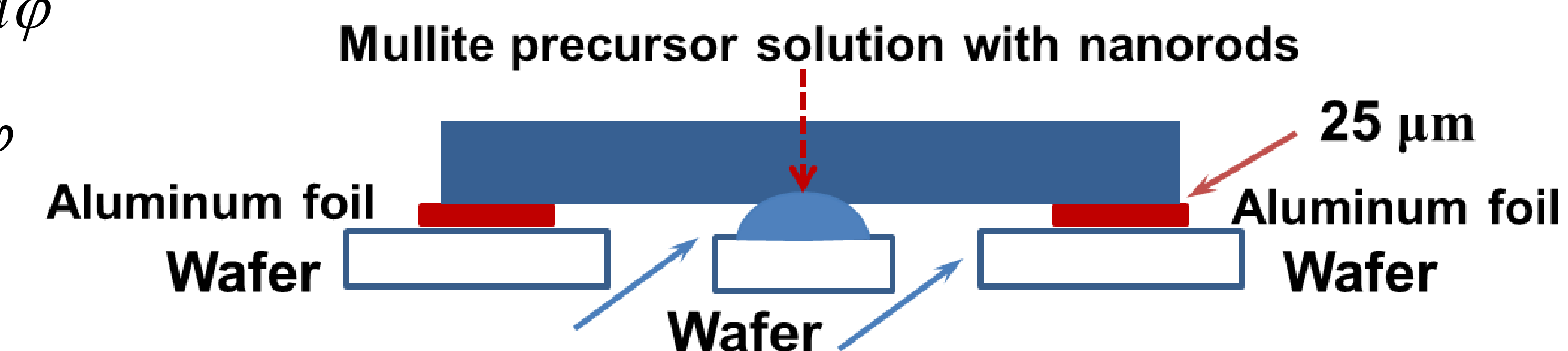
$\eta_0$ : Initial viscosity;  $B$ : External magnetic field;  
 $\tau_0$ : Characteristic time of viscosity increase;  
 $d$ : Diameter of nanorod;  $l$ : Length of nanorod;  
 $m$ : Magnetic moment of nanorod;  $A \approx 2.4$

## Collective kinetics of nanorods

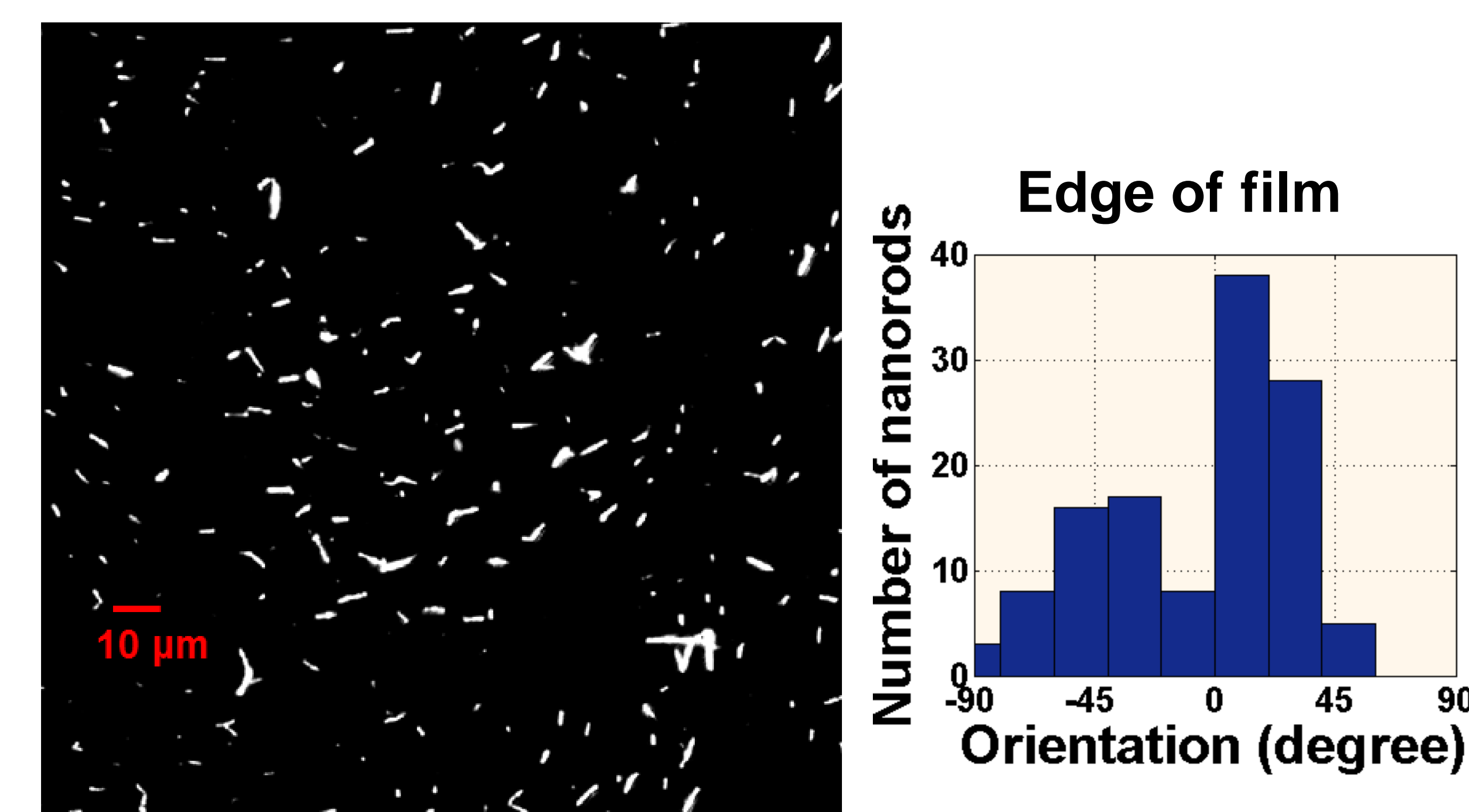
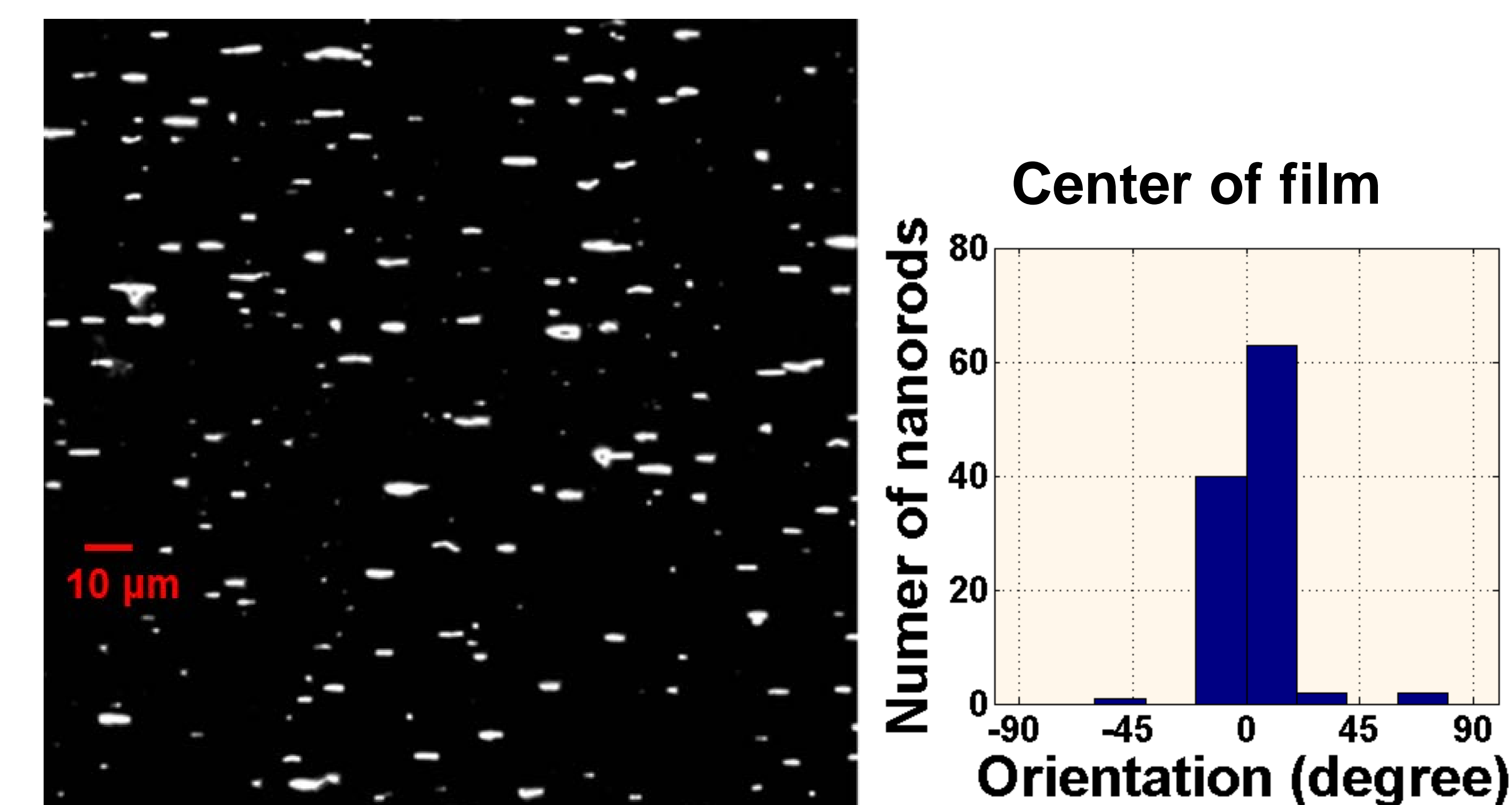
Distribution function  $F$  and probability to orient nanorods  $P$  at time  $t$ .



## Film formation

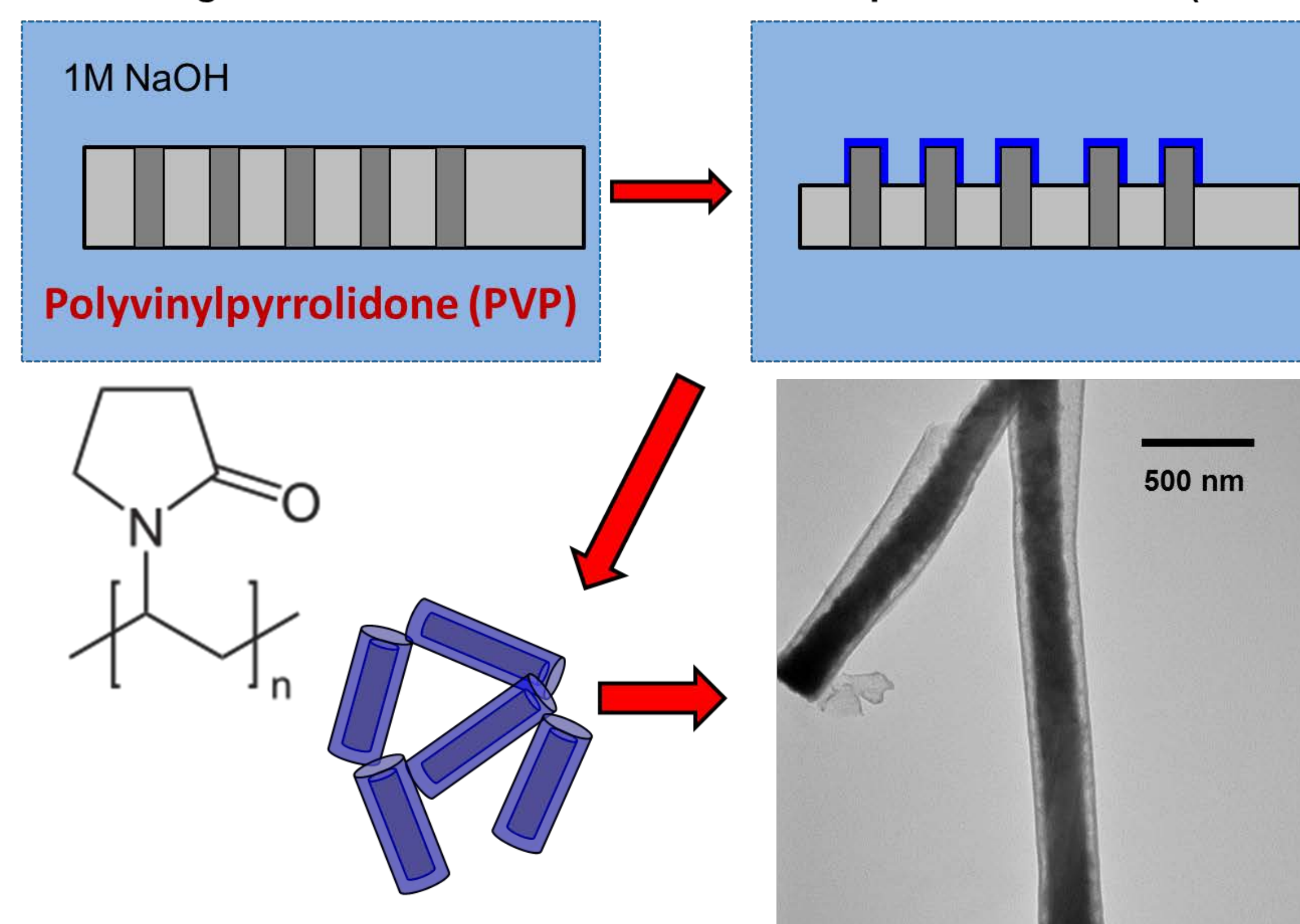


## Orientation distribution

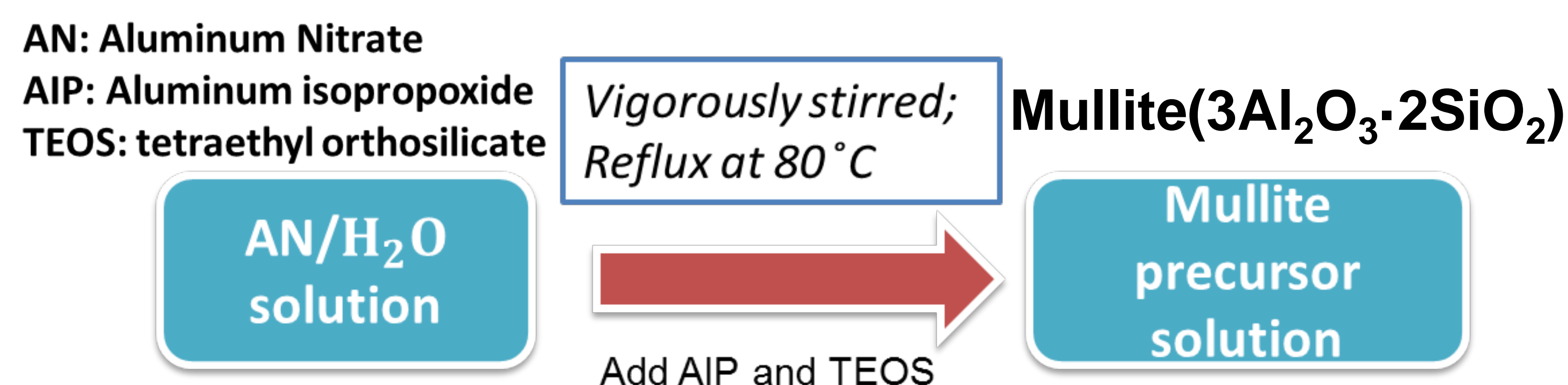


## Surface modification of nanorods

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



## Film formation



## 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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