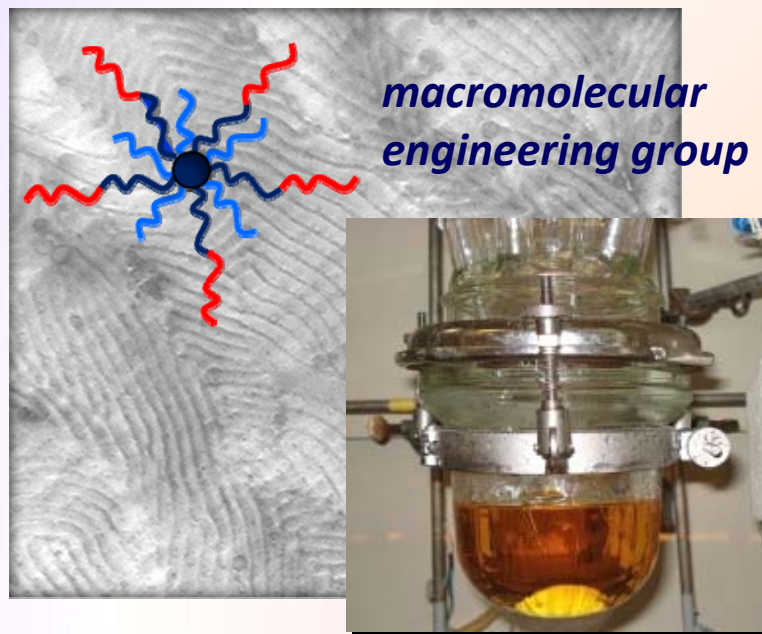


# SUSTAINED DRUG RELEASE THROUGH REVERSIBLE HYDROGEL/LIPOSOME FORMULATIONS

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and  
Institute of Chemical Engineering and High Temperature Chemical Processes,  
FORTH/ICE-HT*



# NANOSTRUCTURES FROM MULTISEGMENTED TERPOLYMERS

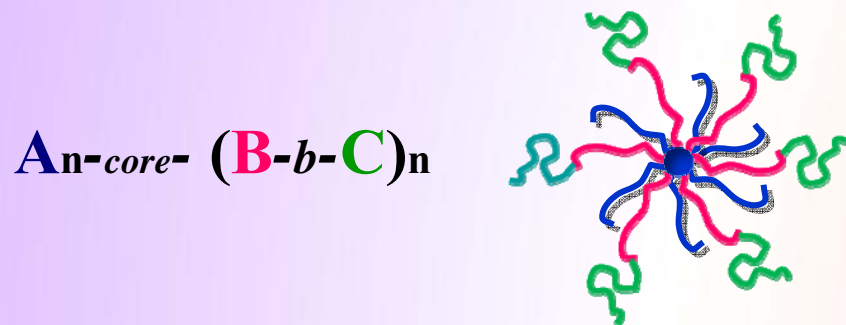
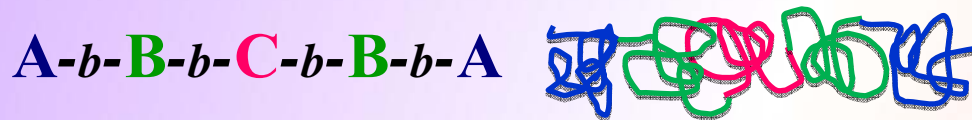
ionogenic monomers: **A**, **B**  
**C** hydrophobic monomer

Self assembly is governed by a variety of interactions

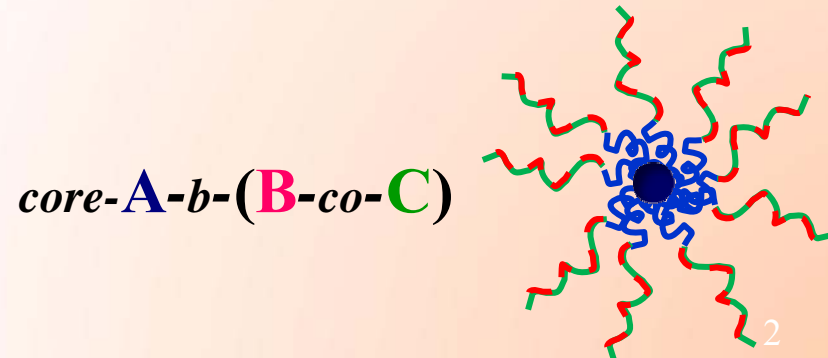
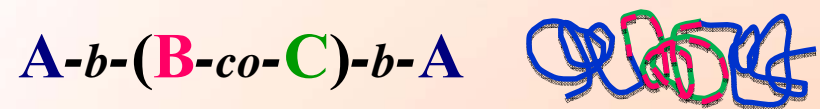
$\chi_{AB}$   $\chi_{AC}$   $\chi_{BC}$  in aqueous media  $\chi_{A H_2O}$   $\chi_{B H_2O}$   $\chi_{C H_2O}$

*Macromolecular architecture, topology*

**Block terpolymer**

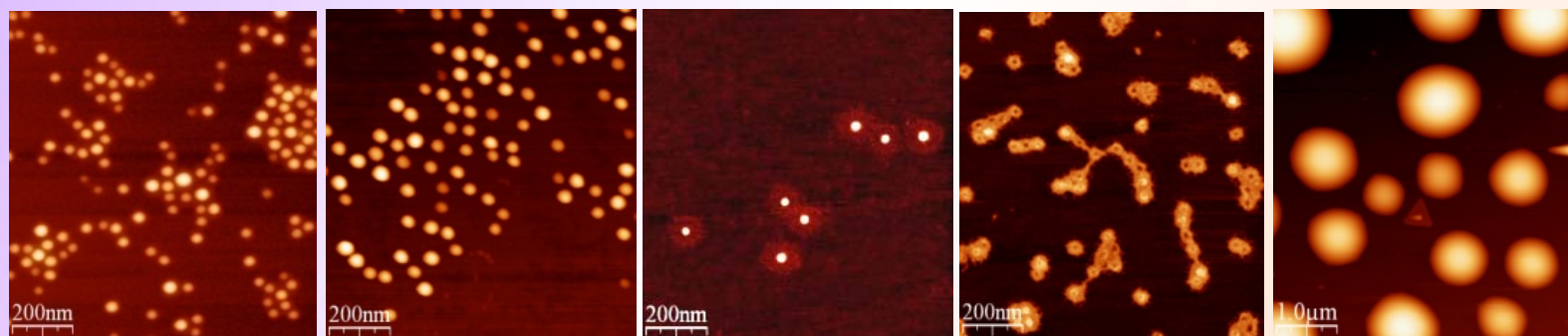


**block random terpolymer**





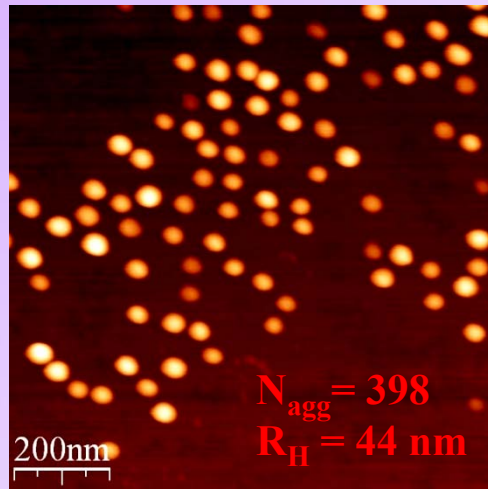
from *bis hydrophilic* to *bis hydrophobic*



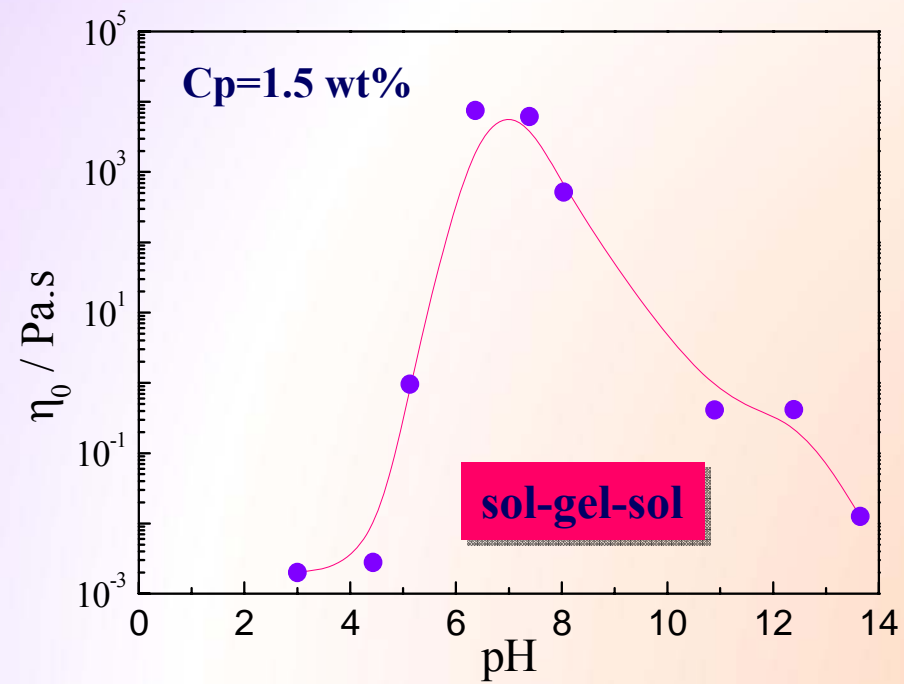
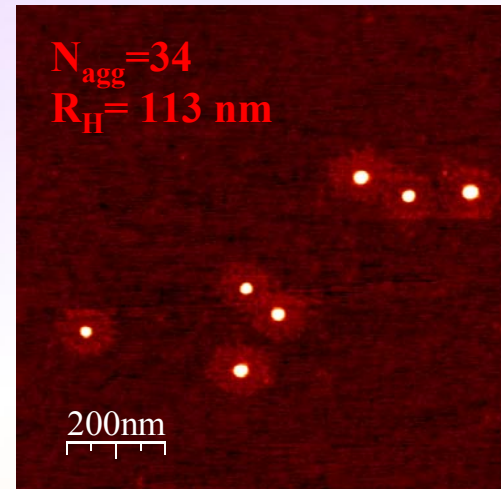
*Macromolecules* 41, 925-934, (2008).

# P2VP<sub>58</sub>-PAA<sub>924</sub>-PnBMA<sub>48</sub>

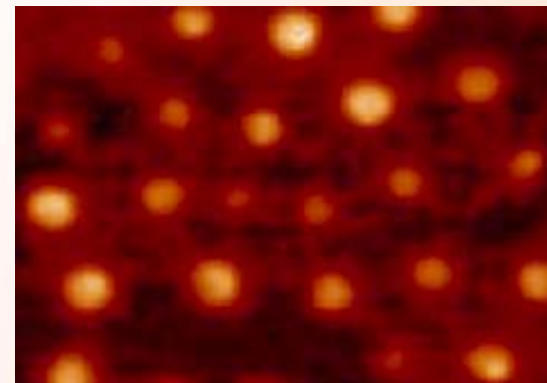
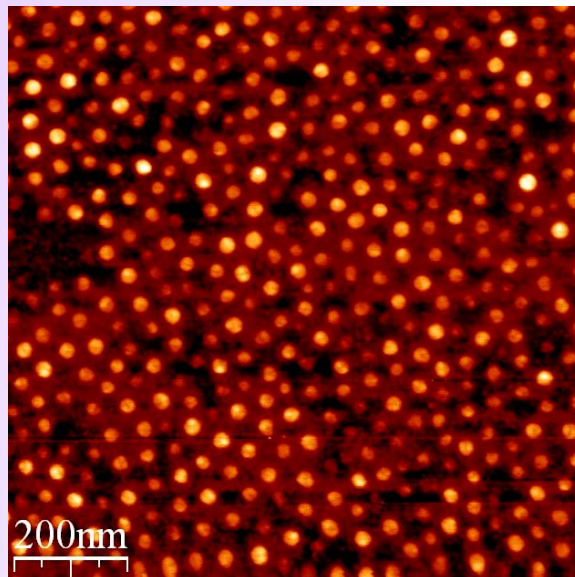
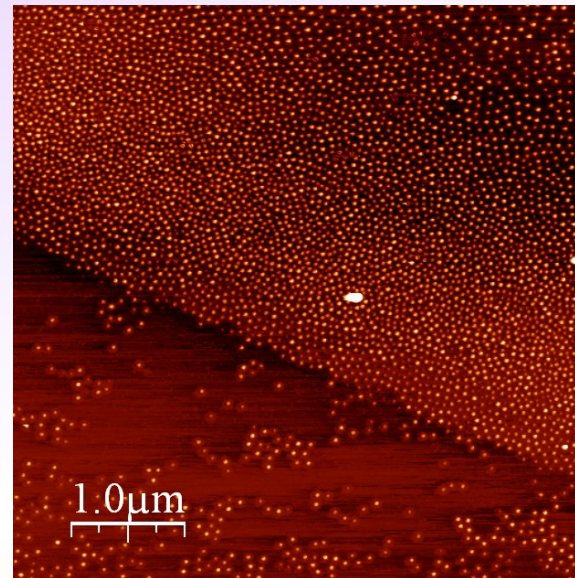
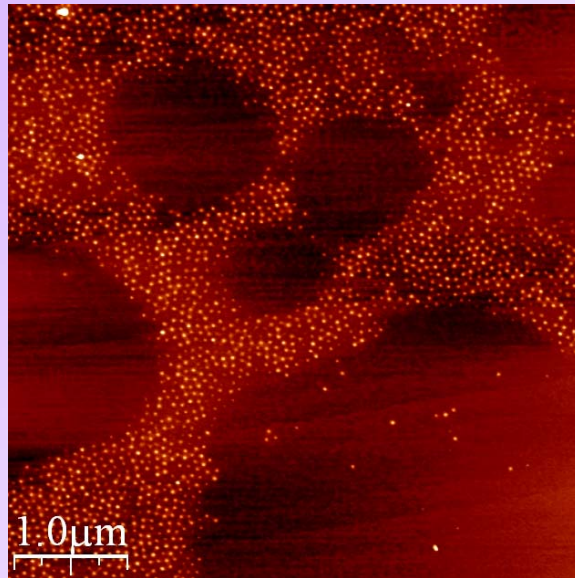
pH 4



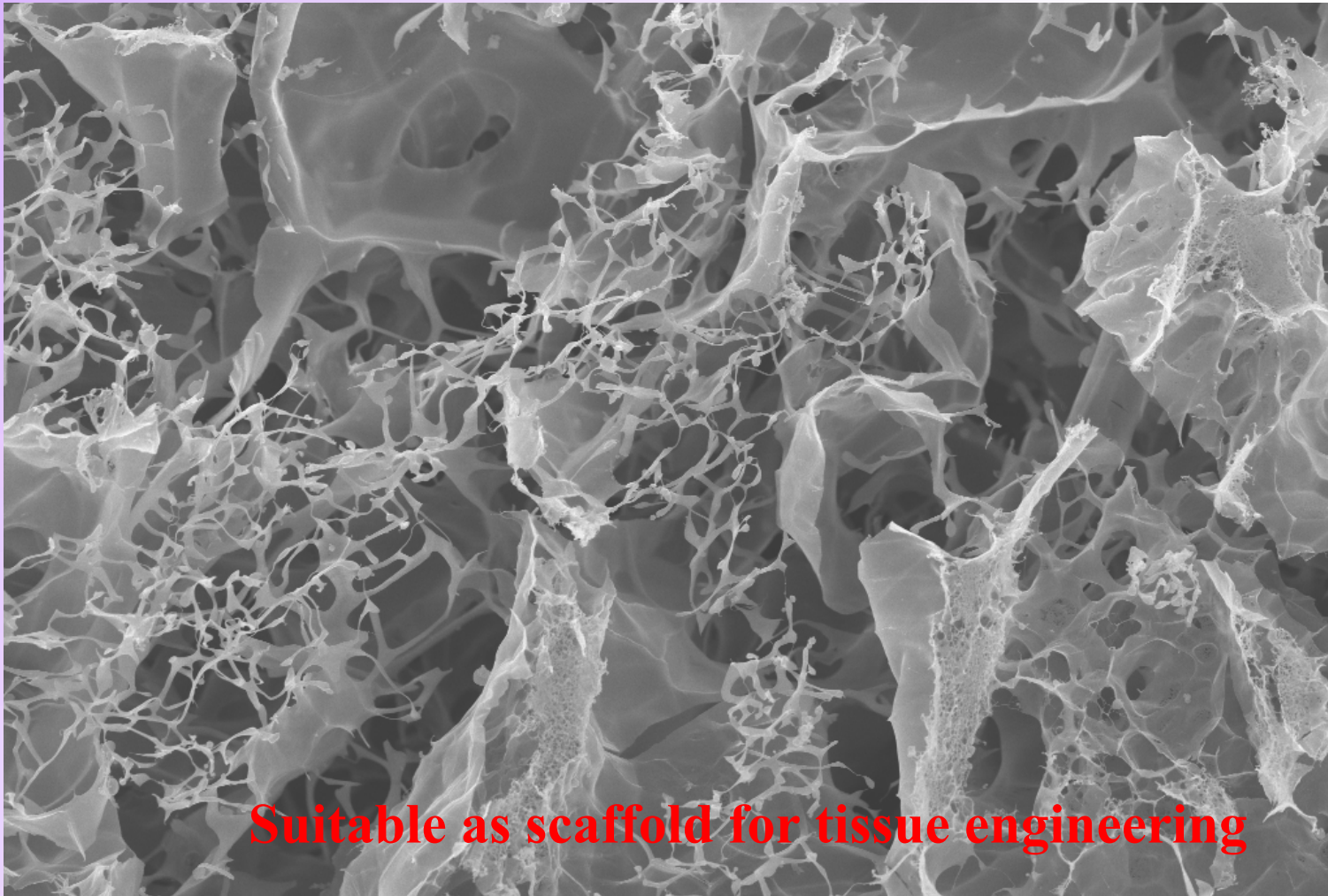
pH 7



## Network growth through loop to bridge transitions



## Hydrogel after freeze drying



**Suitable as scaffold for tissue engineering**

Mag = 918 X

10µm



EHT = 10.00 kV

WD = 5 mm

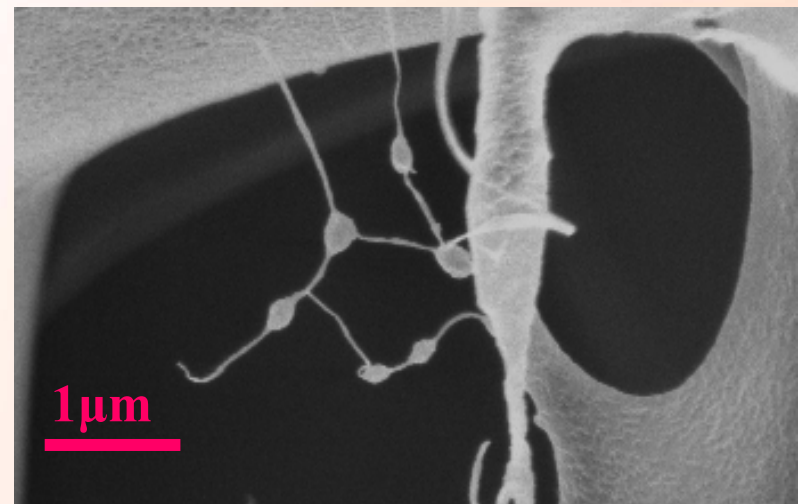
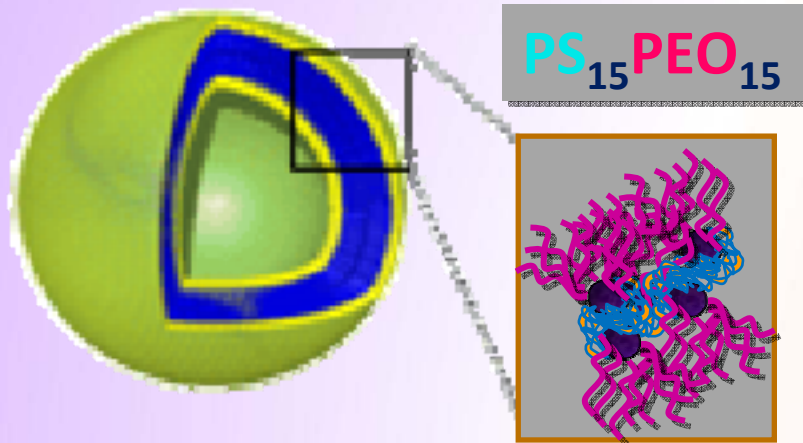
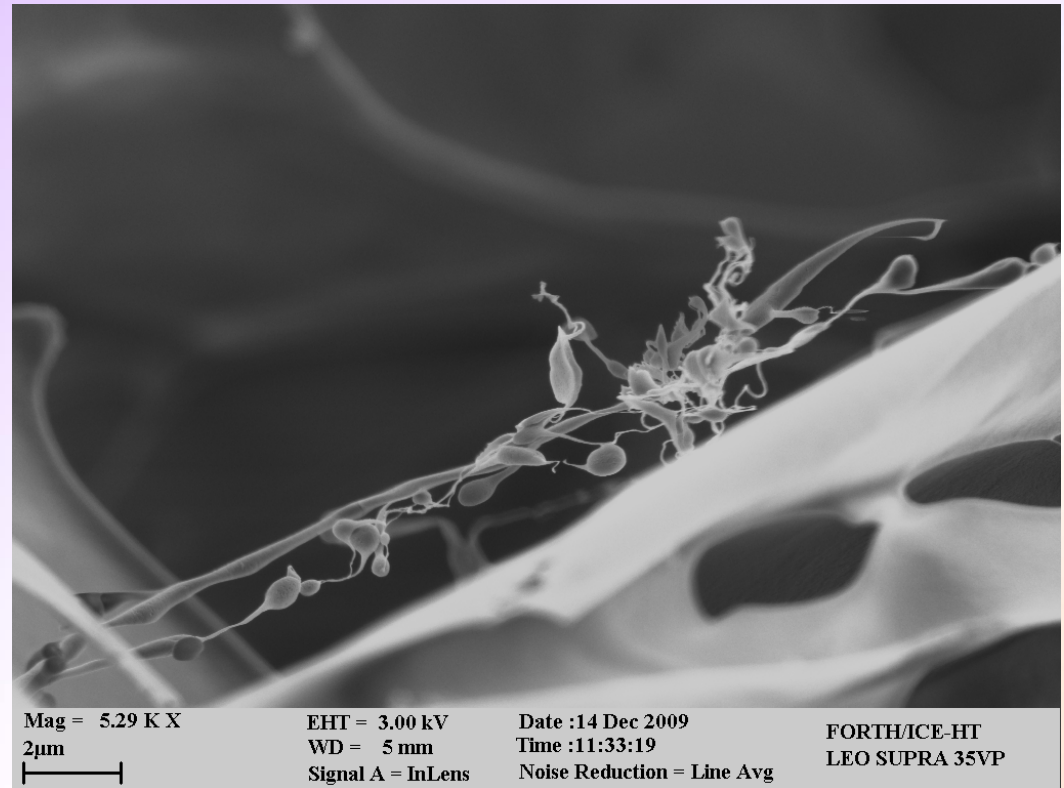
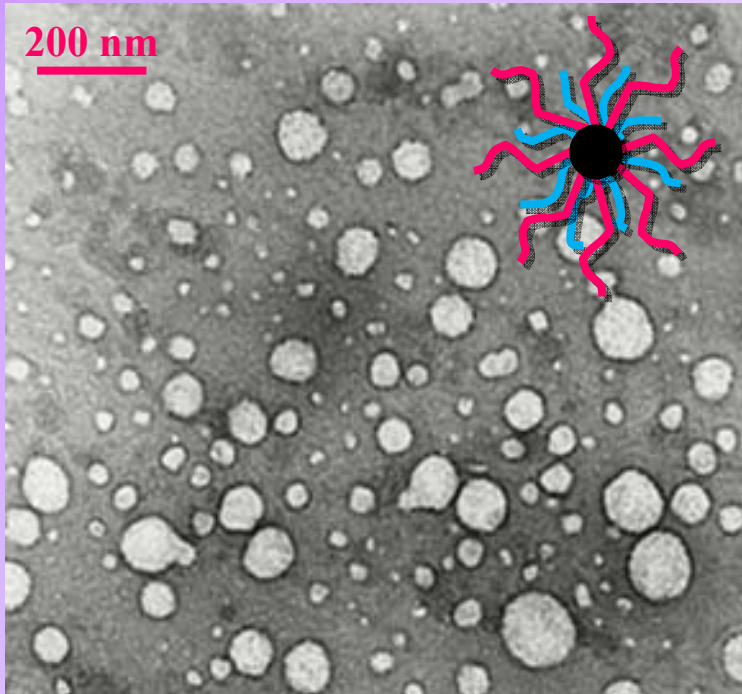
Signal A = InLens

Date :1 Feb 2010

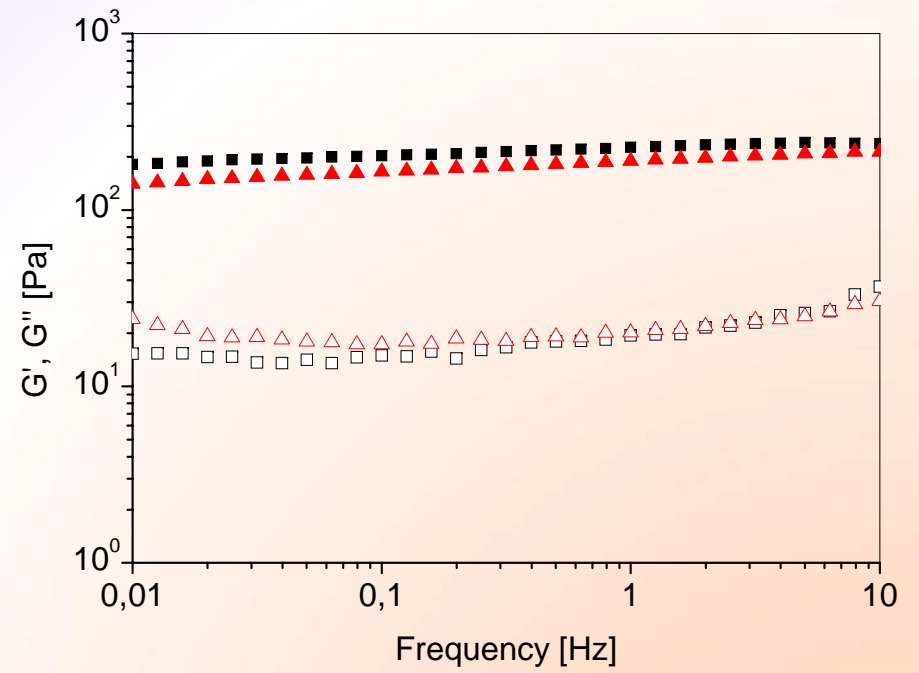
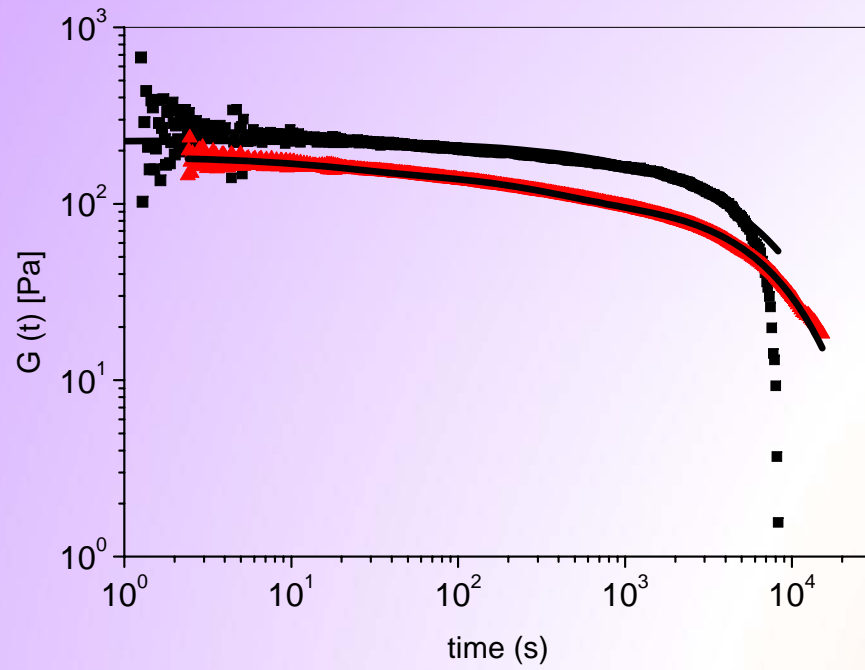
Time :11:24:51

Noise Reduction = Pixel Avg.

FORTH/ICE-HT  
LEO SUPRA 35VP

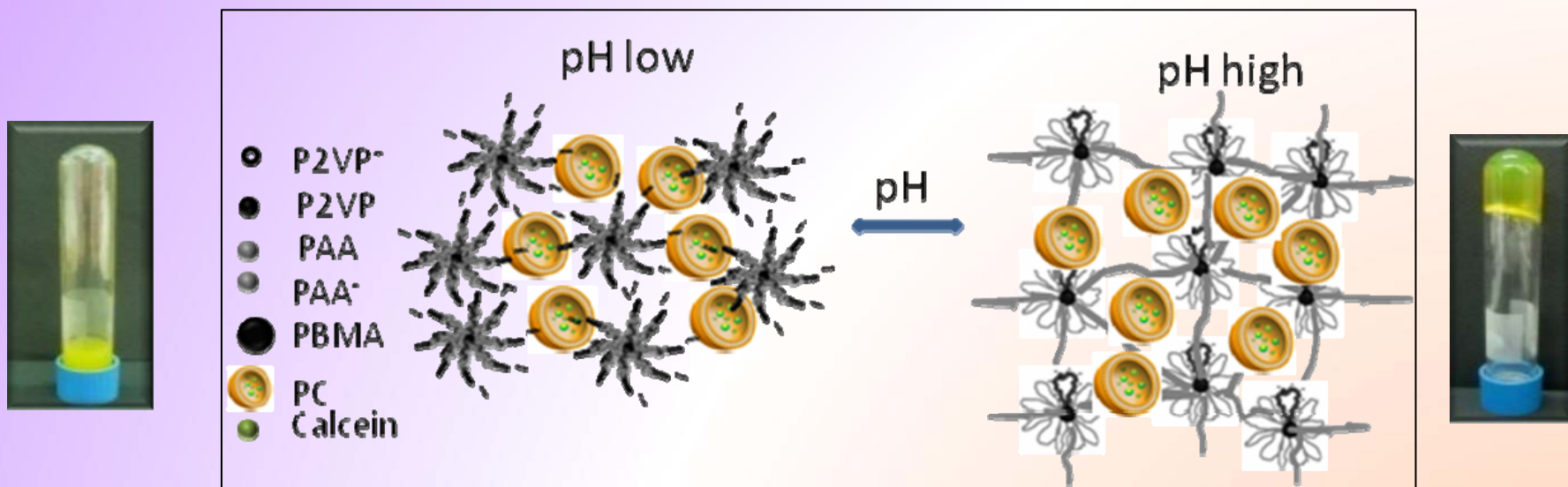


# Rheological Properties



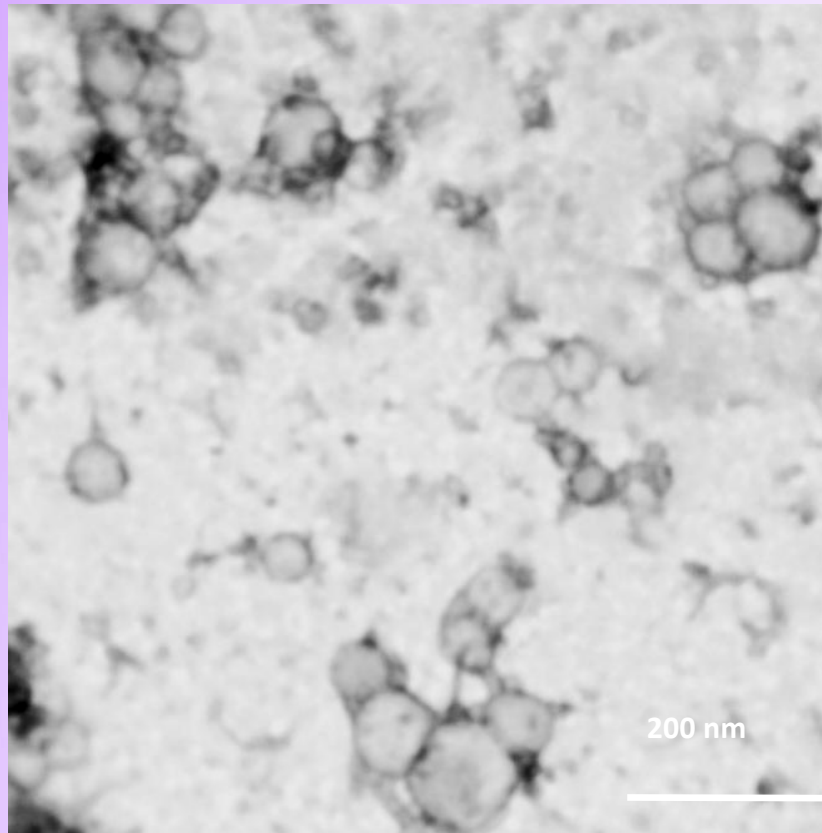


# HYDROGEL/LIPOSOME FORMULATION

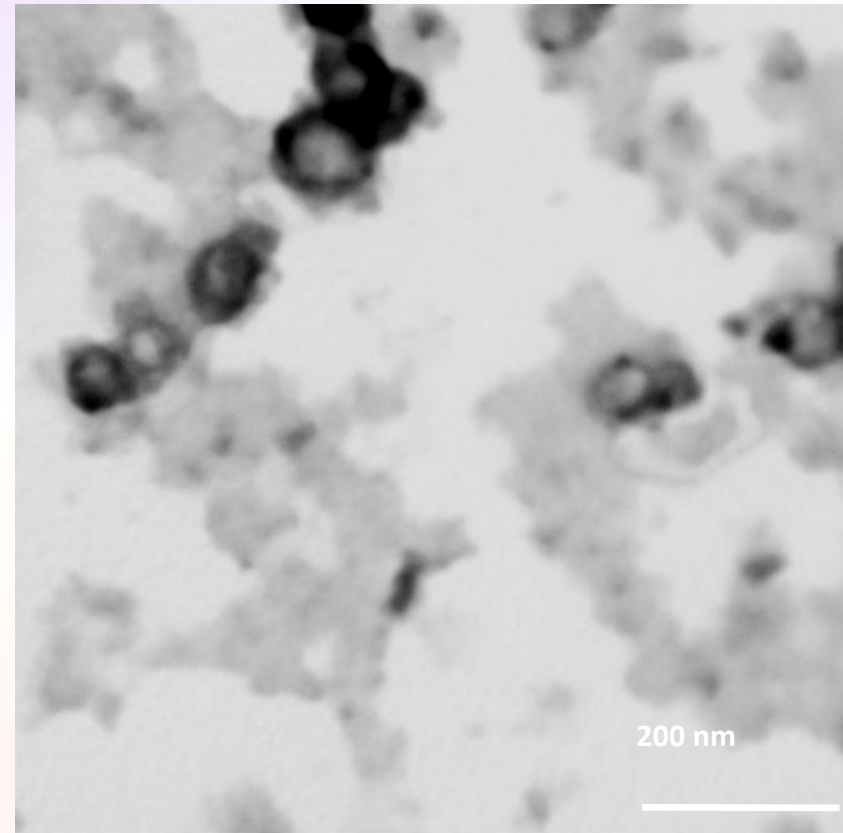


**Injectable hydrogel immobilizing liposomes carrying calcein**

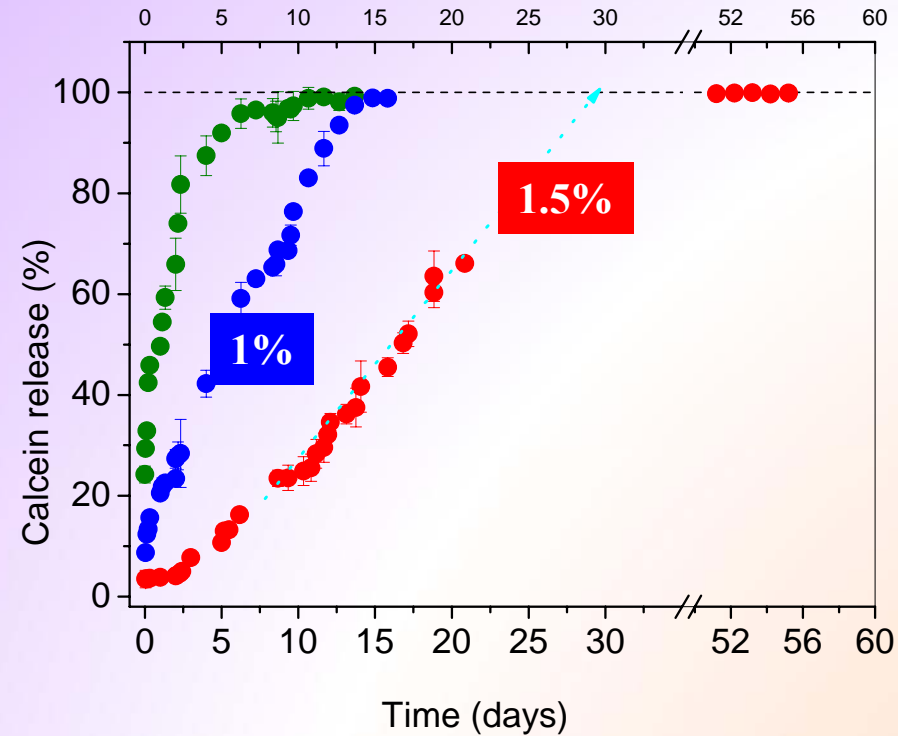
## liposomes



## liposomes/gelator

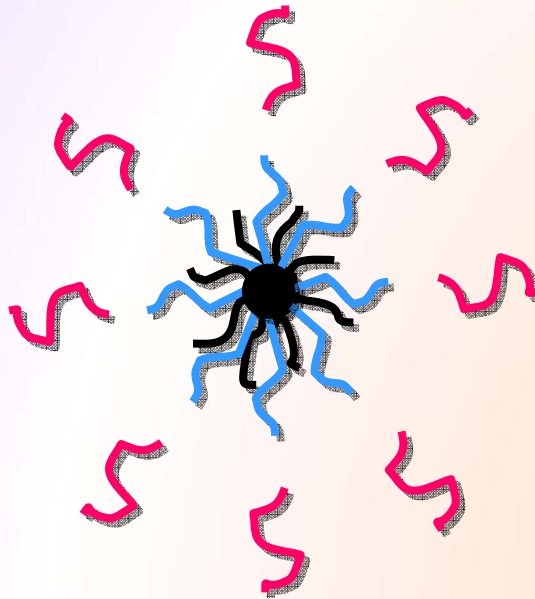
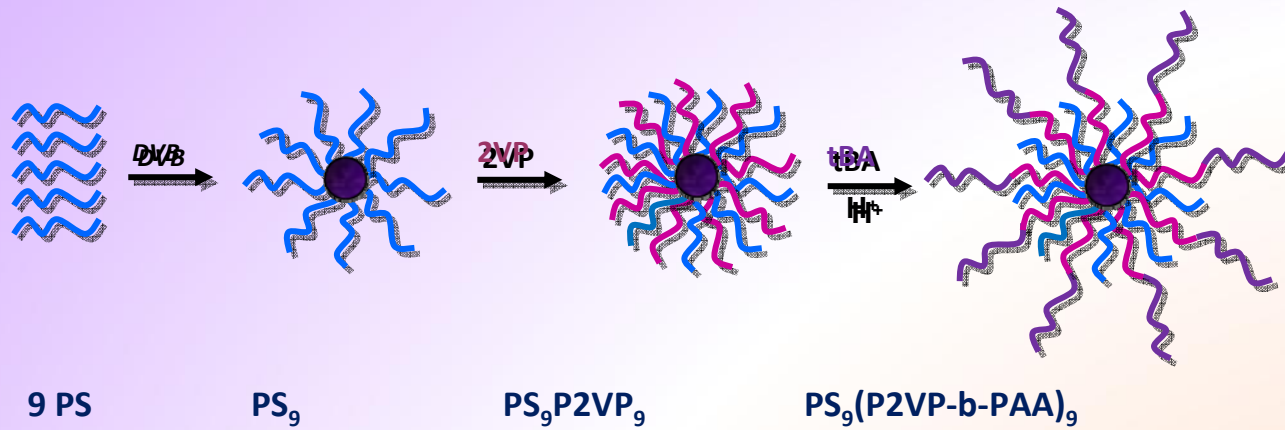


## calcein release kinetics

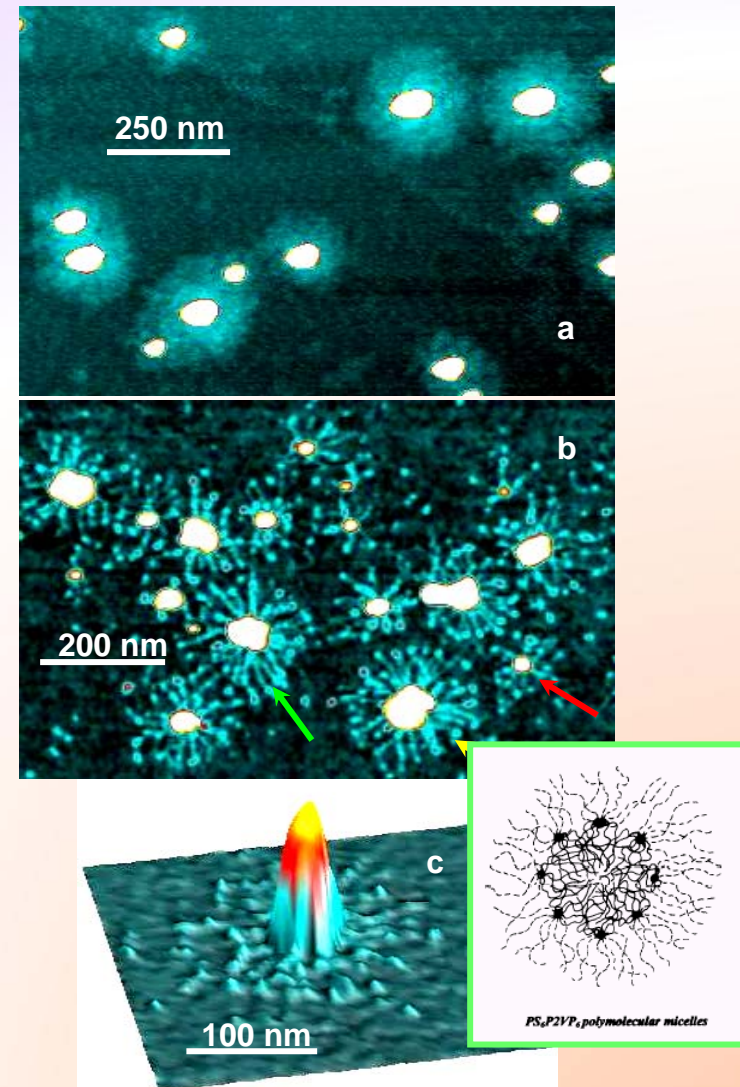
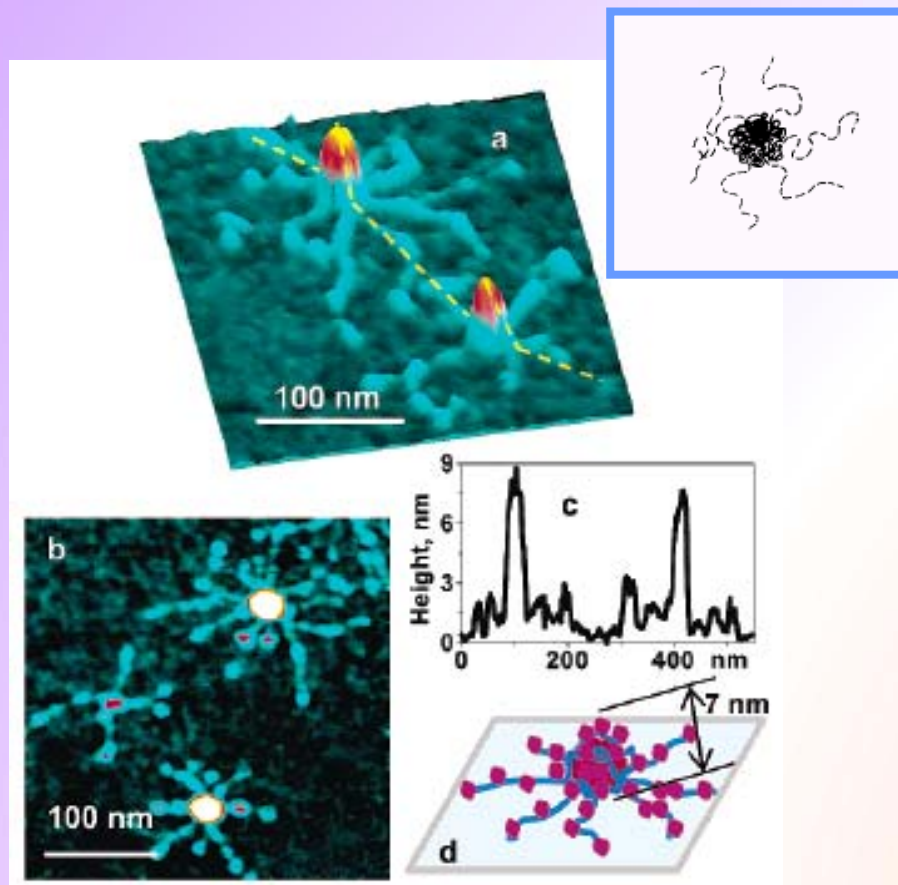


- *Sustained calcein release was achieved at physiological pH through liposome/hydrogel formulation.*
- *Drug release can be tuned by pH, ionic strength and gelator concentration.*

# Multiarm, multisegmented star terpolymers $PS_n(P2VP-PAA)_n$



# PS<sub>7</sub>-core- P2VP<sub>7</sub>

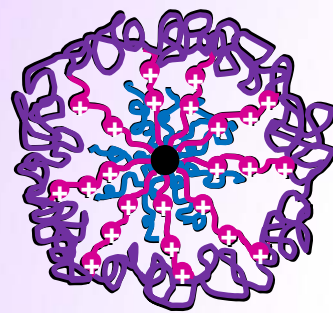
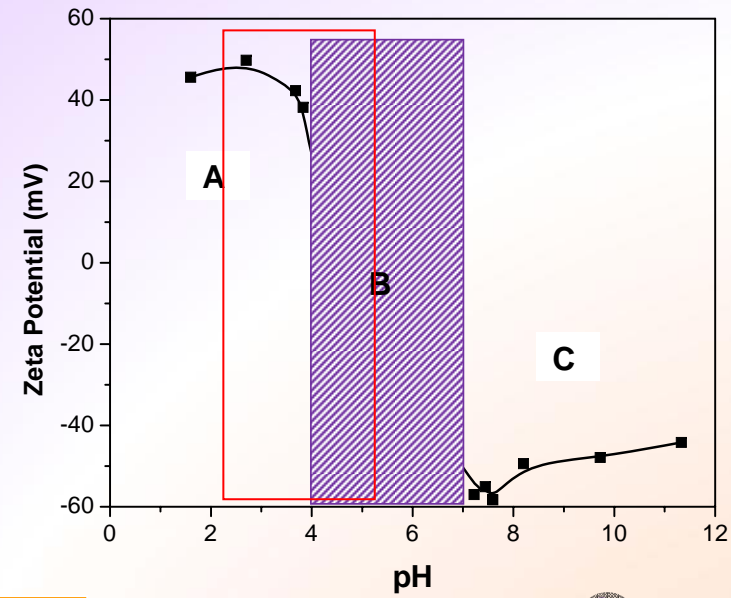
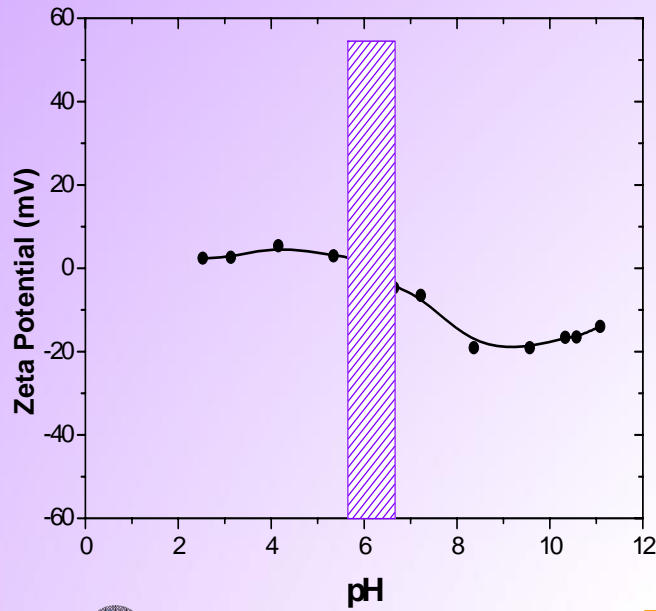


*Macromolecules* **2003**, *36*, 8704-8711  
*Nano Letters*, **2003**, *3*, 365-368

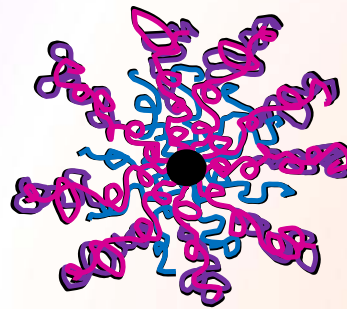
# $(PS_{33})_9\text{-core-}(P2VP_{114}\text{-}PAA_{70})_9$

DMF/H<sub>2</sub>O (1:1)

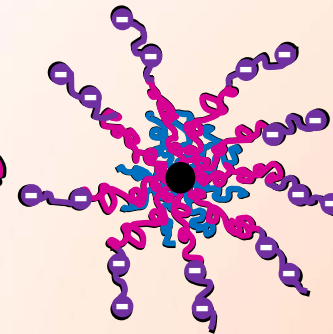
H<sub>2</sub>O



Below *iep*



At *iep*

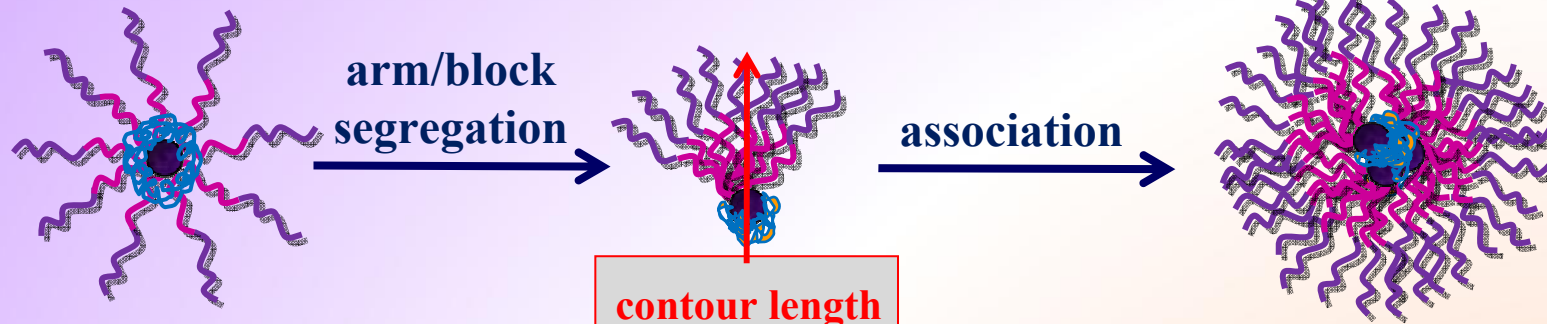


Above *iep*

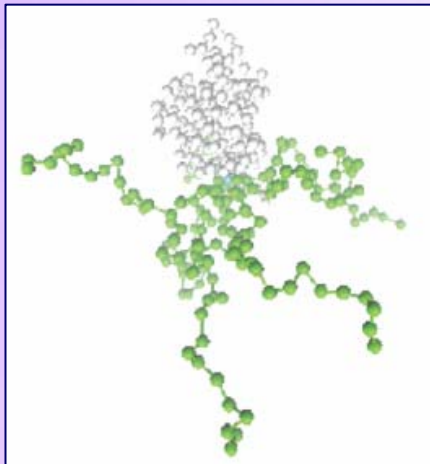


hydrophobic/hydrophilic balance

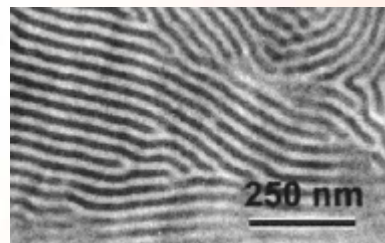
# Arm and block segregation



Maximum diameter ~112 nm

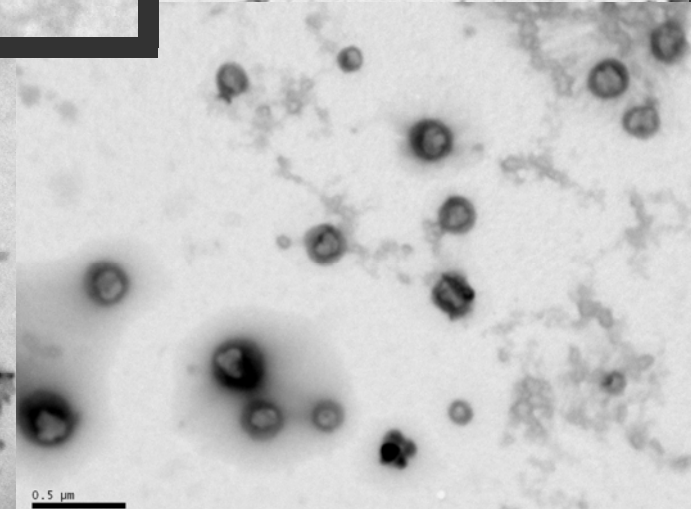
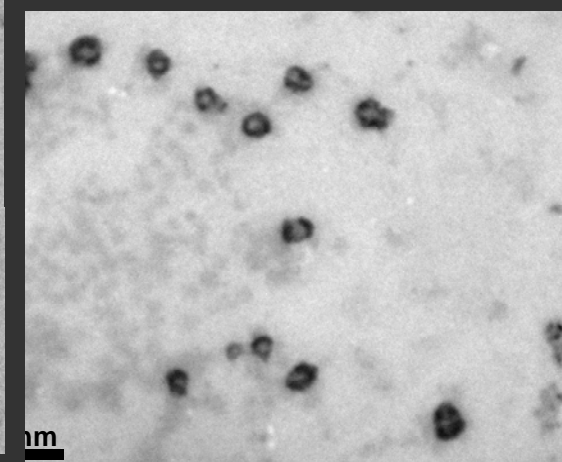
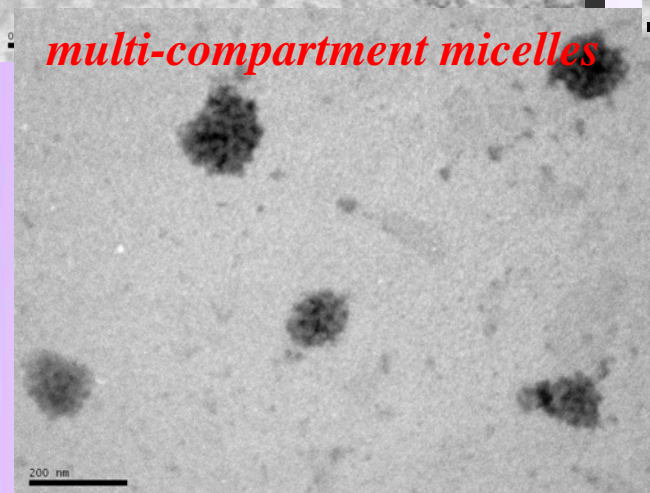
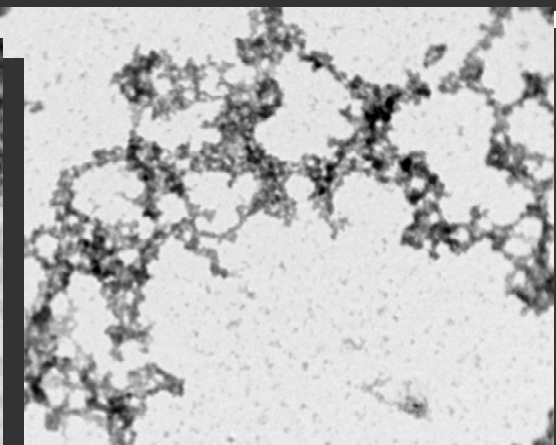
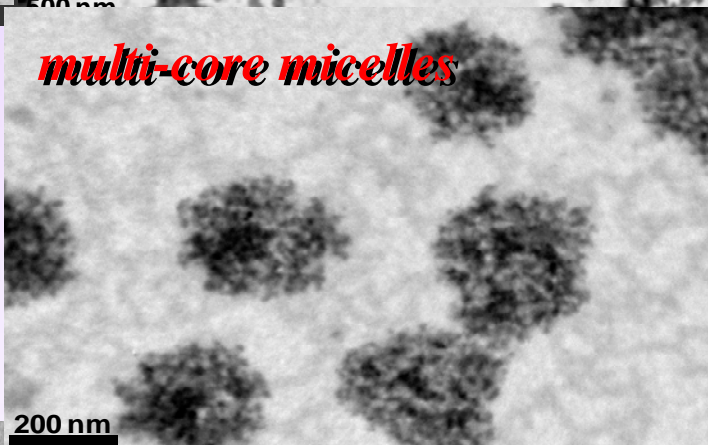
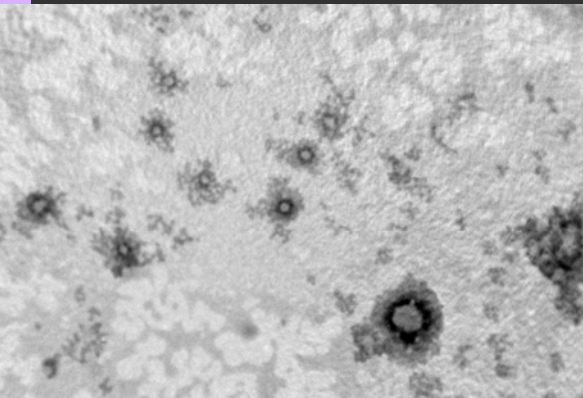
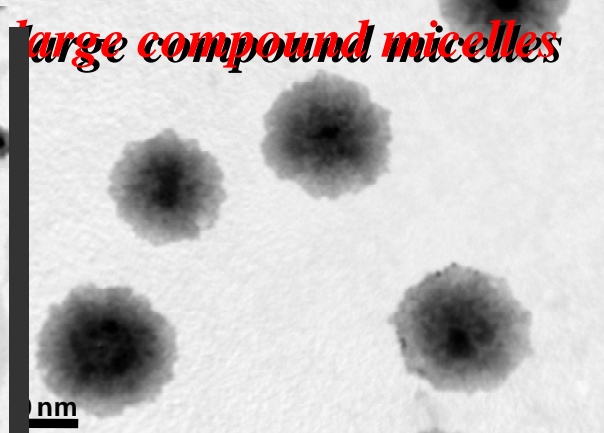
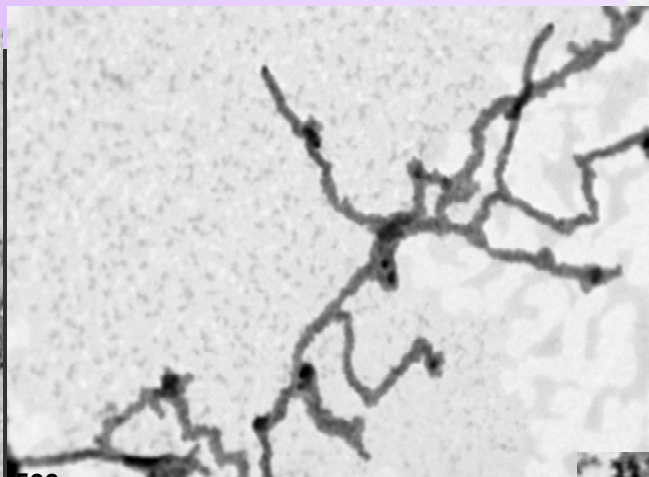
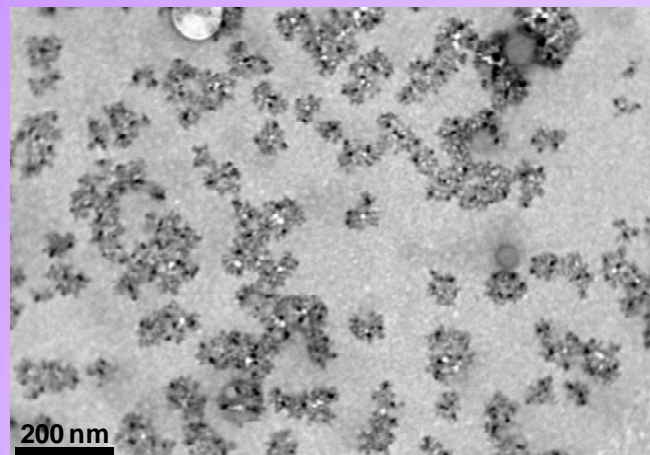


*Macromolecules* **2005**, 38, 6201



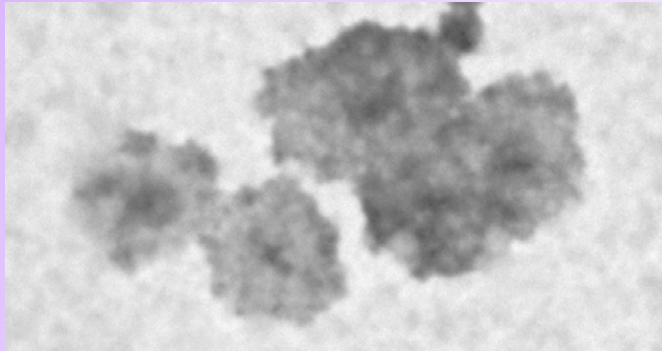
$$\chi_{\text{PS,P2VP}} N_{\text{PS+P2VP}} = 17$$

*Macromolecules* **2000**, 33, 6330.

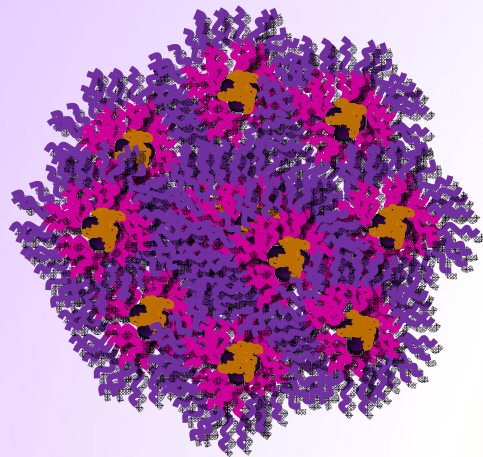




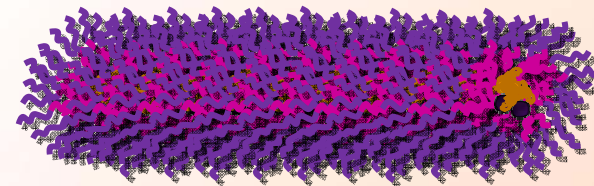
## Association path in low pH



**Hierarchical self-organizations  
through corona interactions**

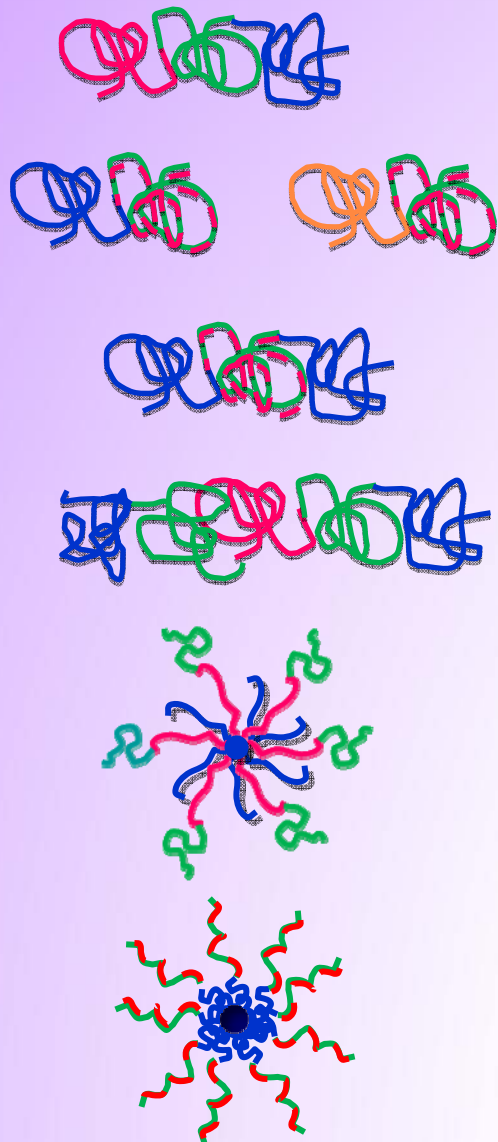


*large compound micelles*



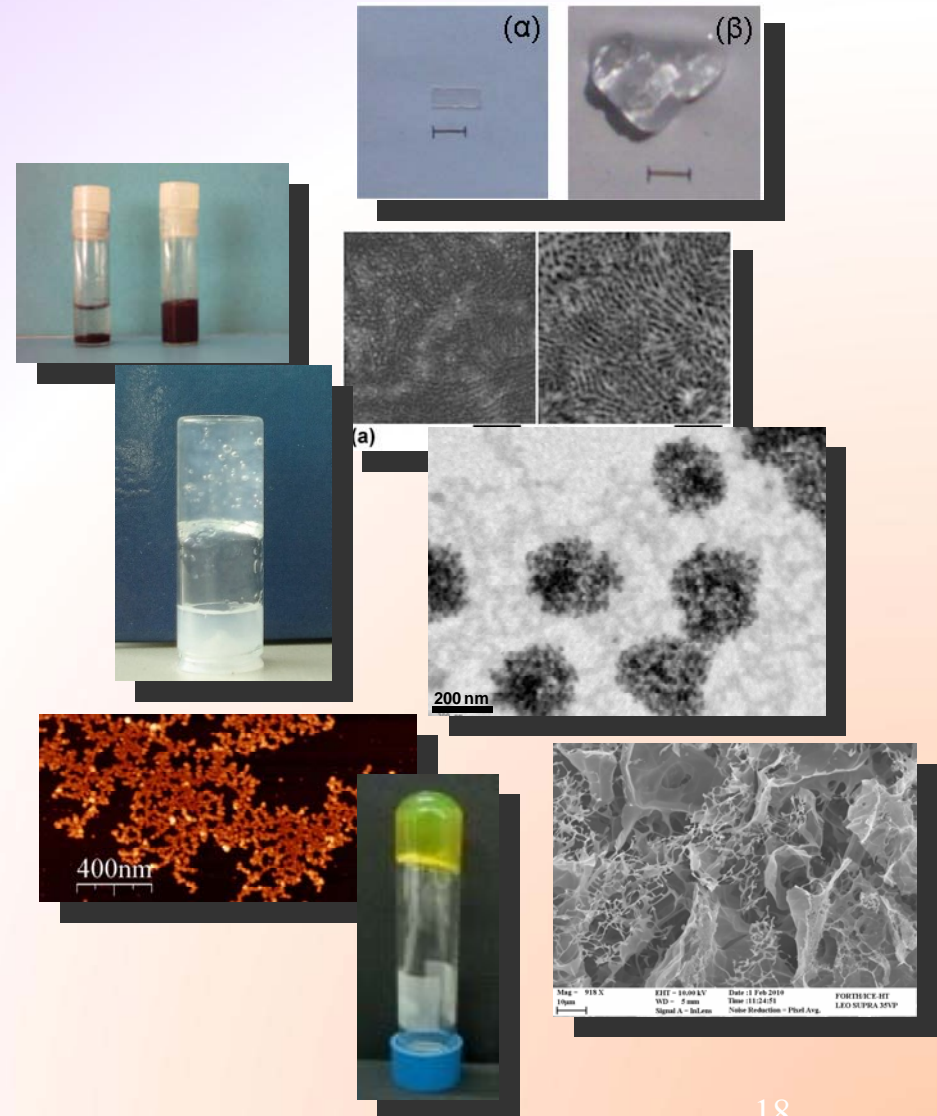
*worm like micelles*

## tailor made polymers



↔  
retro  
design

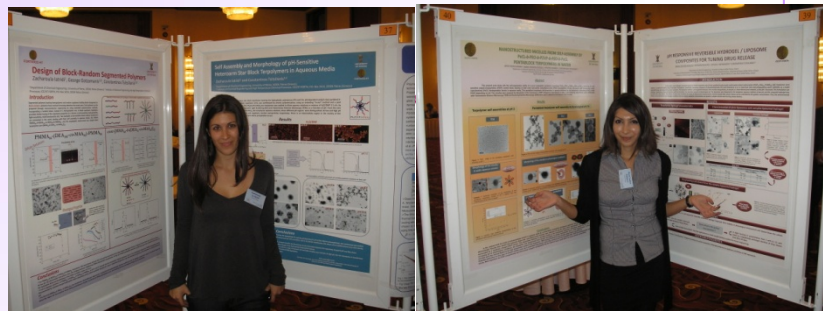
## tailor made polymeric materials



## acknowledgement

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N. Stavrouli



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S. Mourtas

*Department of Pharmacy*

S. Minko  
Y. Roiter

Klarkson University

## Poster award

