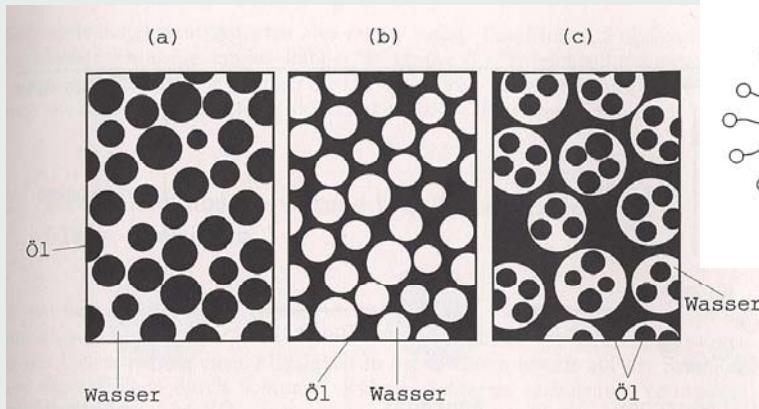
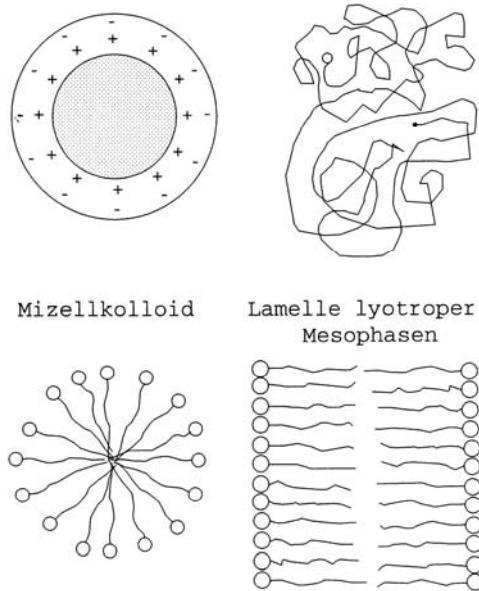


Colloid Science



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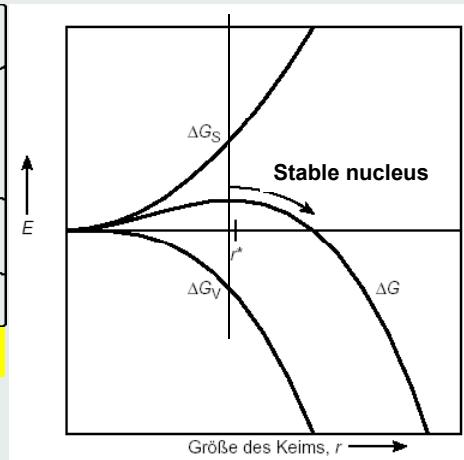
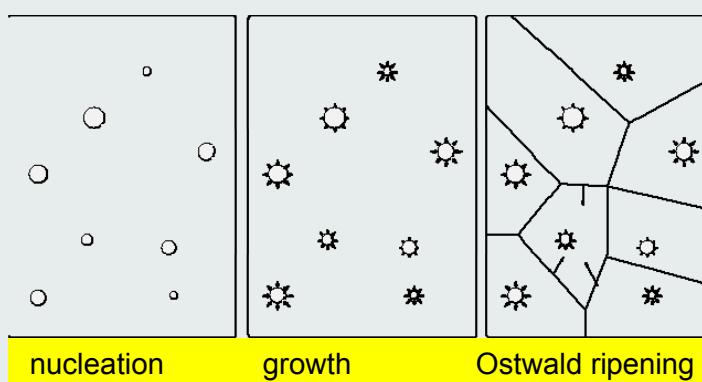
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1

Theory of Nucleation- Thermodynamics

ΔG = free energy of particle with radius r ,
 ΔG_s = surface tension of particle with radius r ,
 ΔG_v = bulk or volume energy of particle with radius r ,
particles with $r < r^*$ dissolve again; particles with $r > r^*$ grow on

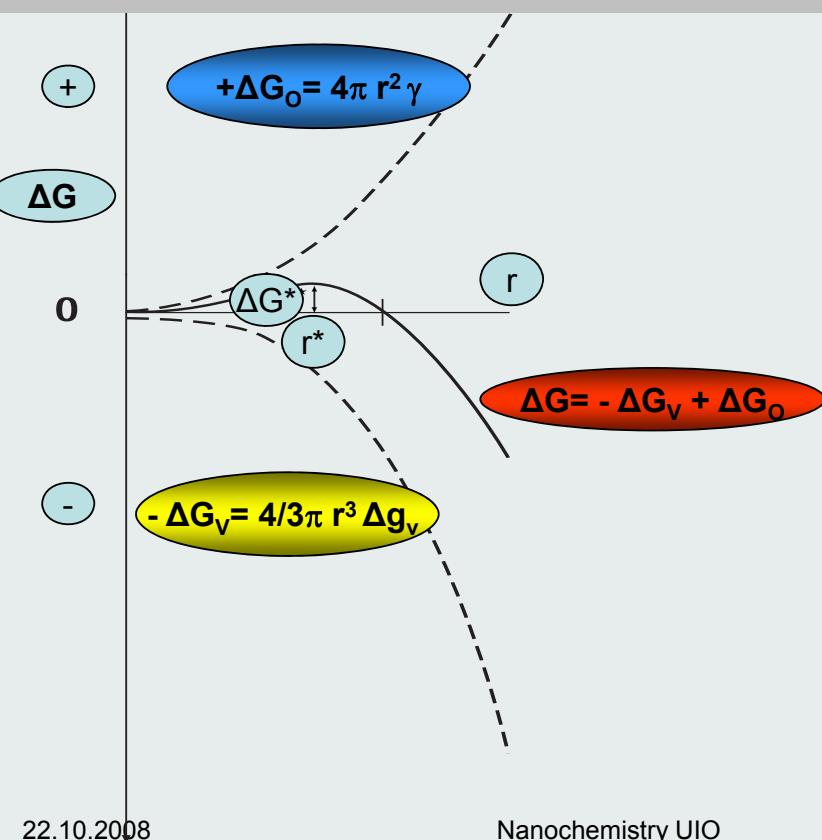


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2

Free Enthalpy (ΔG) as Function of Nucleus Radius (r)



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3

Critical Nucleus and Nucleation Rate

$$\Delta G = \Delta G_s - \Delta G_v = 4\pi r^2 \gamma - \frac{4}{3} \pi r^3 \Delta g_v$$

$$r^* = -2\gamma/\Delta g_v$$

γ = surface tension

Δg_v = energy difference of liquid and solid phase

r^* = critical radius of nucleus

$$J = A \exp(-\Delta G^*/kT)$$

$$J = A \exp(-(16\pi\gamma^3 v^2)/(3k^3 T^3 [\ln S]^2))$$

$$kT \ln(S) = 2\sigma v/r$$

J = nucleation rate

S = supersaturation

Supersaturation is dependent on the radius of the particle r

$S = c(r)/c^*$

$c(r)$ = solubility of particle with radius r

c^* = solubility of equilibrium particles with r^*

v = molecular volume

r^* = critical radius of nucleus

Super Saturation

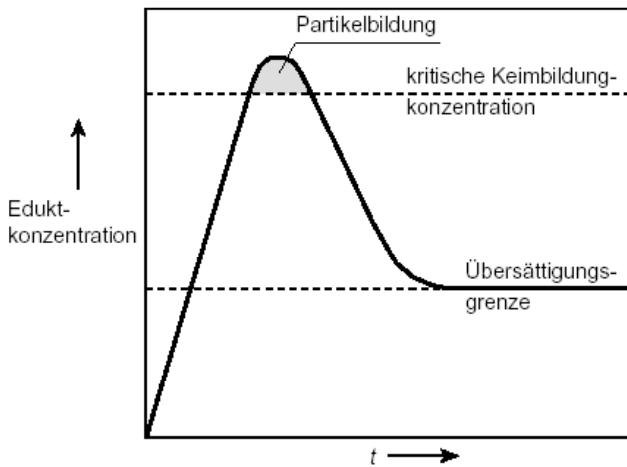


Abbildung 5. Schematische Darstellung der Konzentrationsverhältnisse bei der kontrollierten Partikelbildung gemäß der Modellvorstellung von LaMer^[18a] (Erläuterung siehe Text).

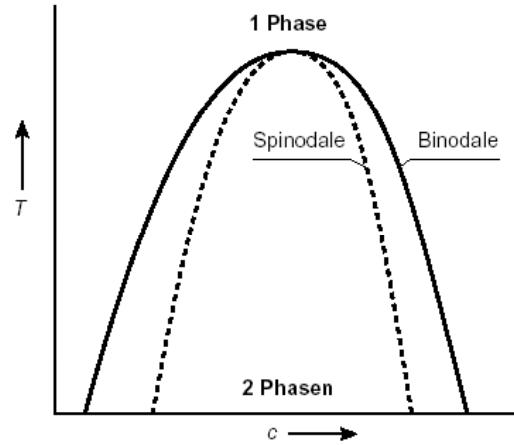


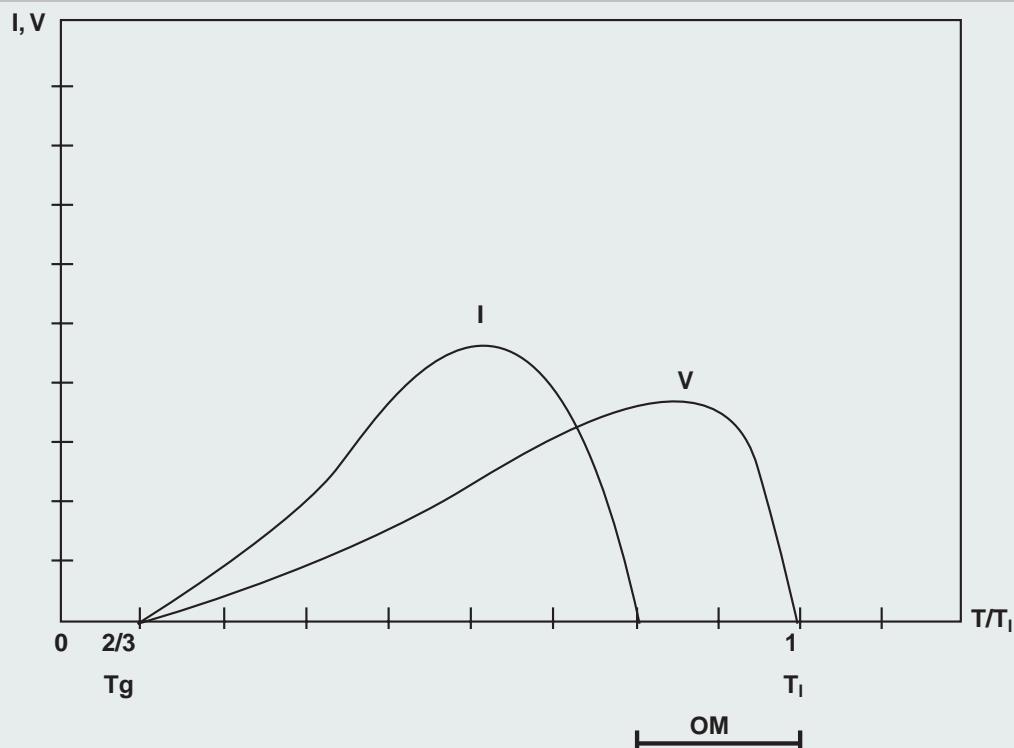
Abbildung 6. Phasendiagramm eines Zweikomponentensystems mit Mischbarkeitslücke. Der Bereich zwischen den Kurven für binodale und spinodale Entmischung (Binodale bzw. Spinodale) entspricht dem metastabilen Bereich, in dem gemäß der klassischen Theorien die Teilchenbildung durch Keimbildung und Wachstum abläuft, während sich das System unterhalb der Spinodalen spontan entmischt.

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5

Rate of Nucleation (I) and of Crystallization (V)



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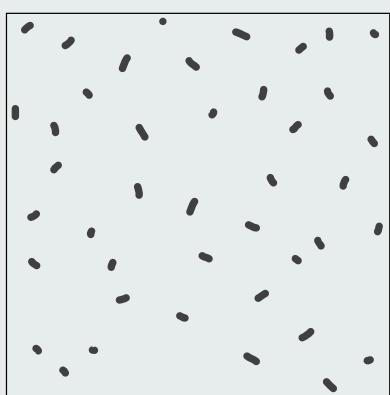
6

Nucleation

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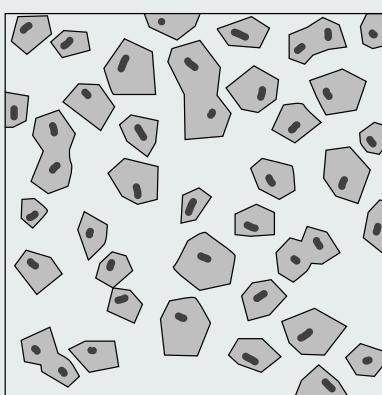
Nucleation
↓
Partikelbildungsprozess

Volume Nucleation



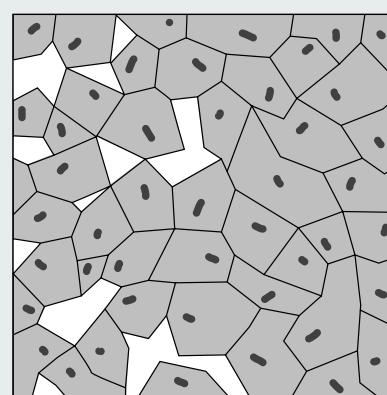
a)

nucleation



b)

Crystal growth



c)

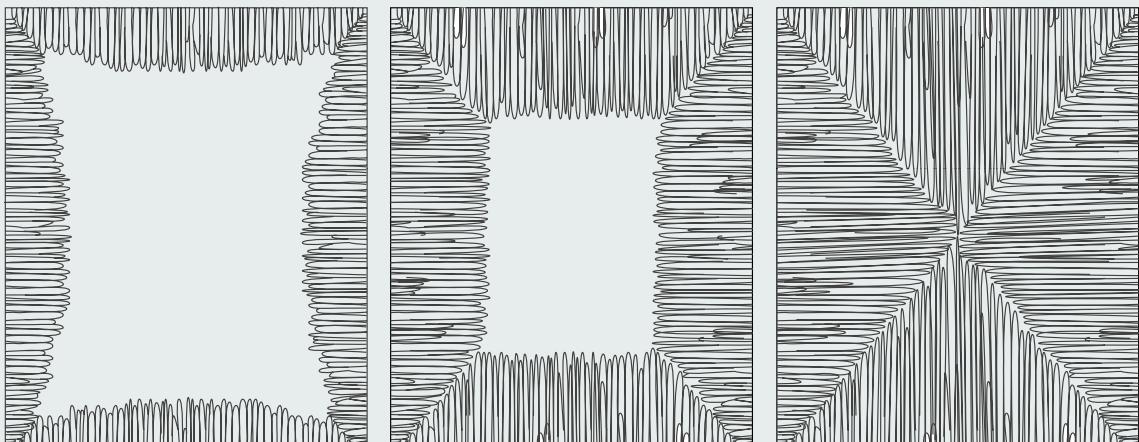
Glas ceramics

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Surface crystallization



a)

b)

c)

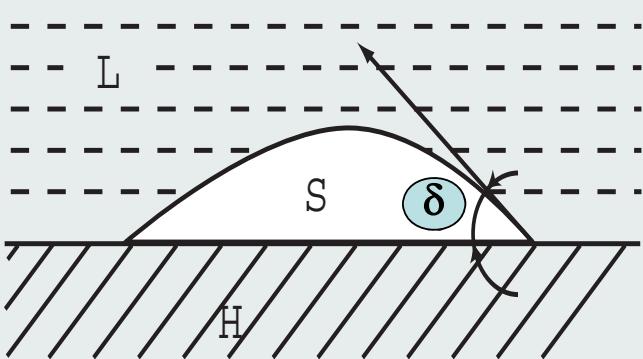
crystallization without volume nucleation

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Heterogeneous Nucleation



$$\Delta G_H^* = \Delta G^* f(\delta)$$

$$f(\delta) = (2 + \cos \delta)(1 - \cos \delta)^2 / 4$$

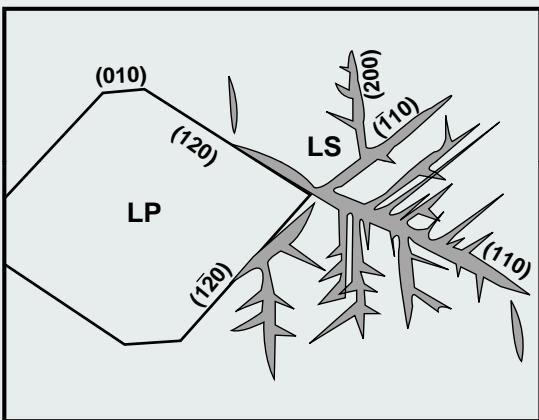
L = liquid, mother phase
S = nucleus, FK
H = heterogeneous substrate, catalyst
 δ = contact angel

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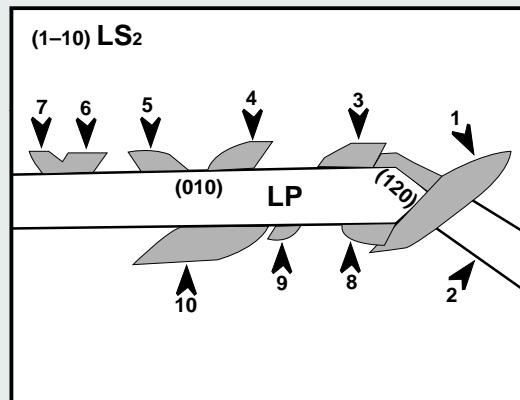
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Epitaxial Growth



Growth of Li_2SiO_3 (LS)
on Li_3PO_4 (LP)



Growth of $\text{Li}_2\text{Si}_2\text{O}_5$ (LS2)
on Li_3PO_4 (LP)

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Micelles and Vesicles

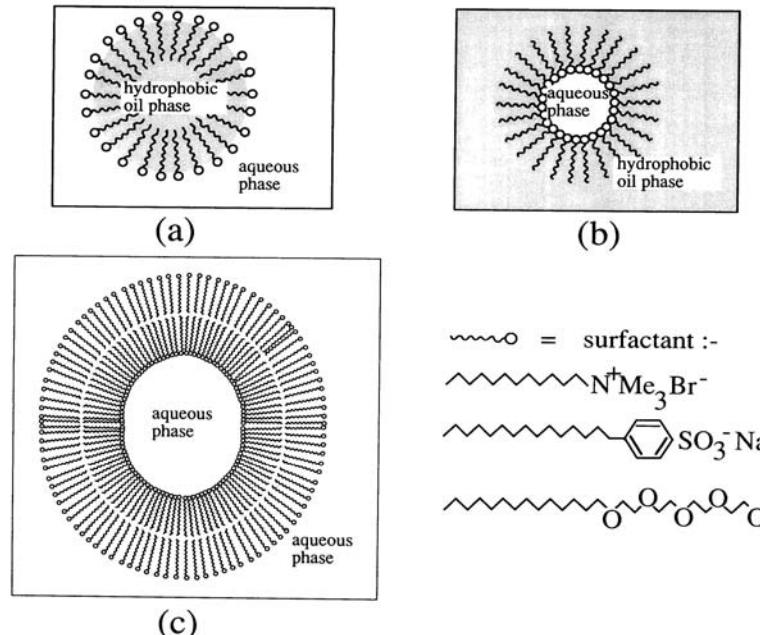


Figure 6-10. a) Surfactant oil in water micelles, b) water-in-oil reverse micelles, and c) vesicles. Metal colloids can be generated in the intraparticle space.

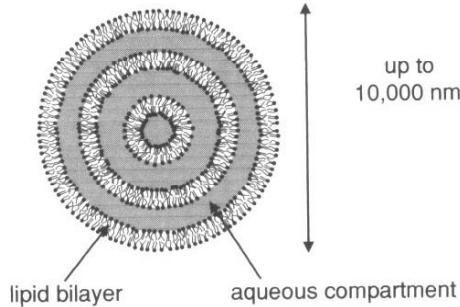
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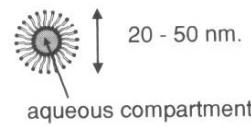
12

Micelles and Vesicles

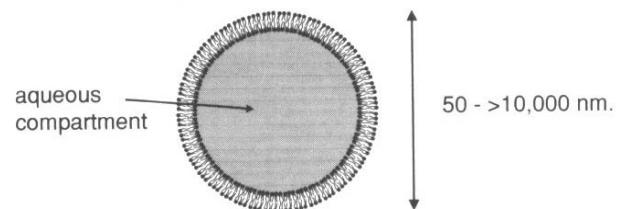
Multilamellar vesicle (MLV)



Small unilamellar vesicle (SUV)



Large unilamellar vesicle (LUV)

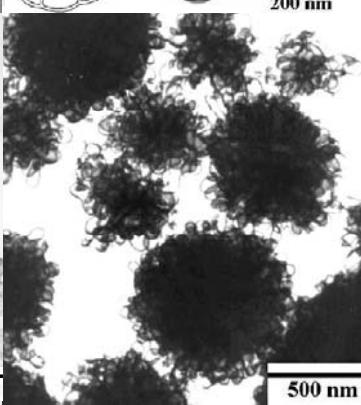
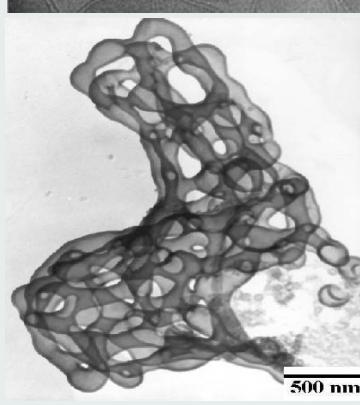
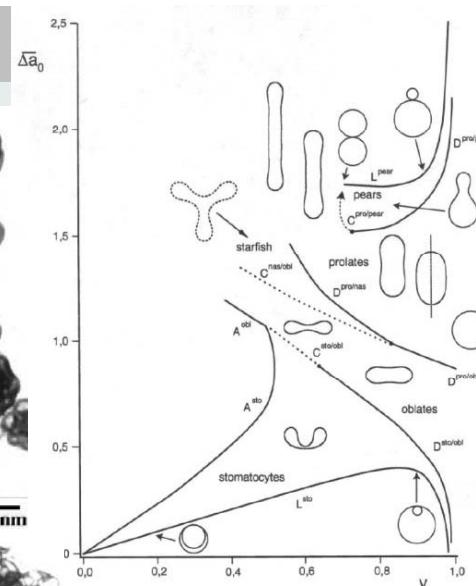
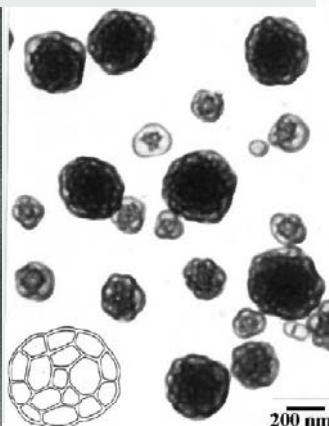
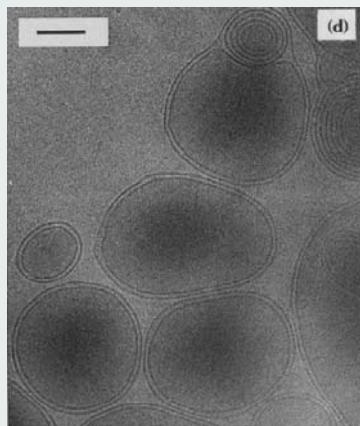


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Forms and Transforms



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Vesicles - Classification

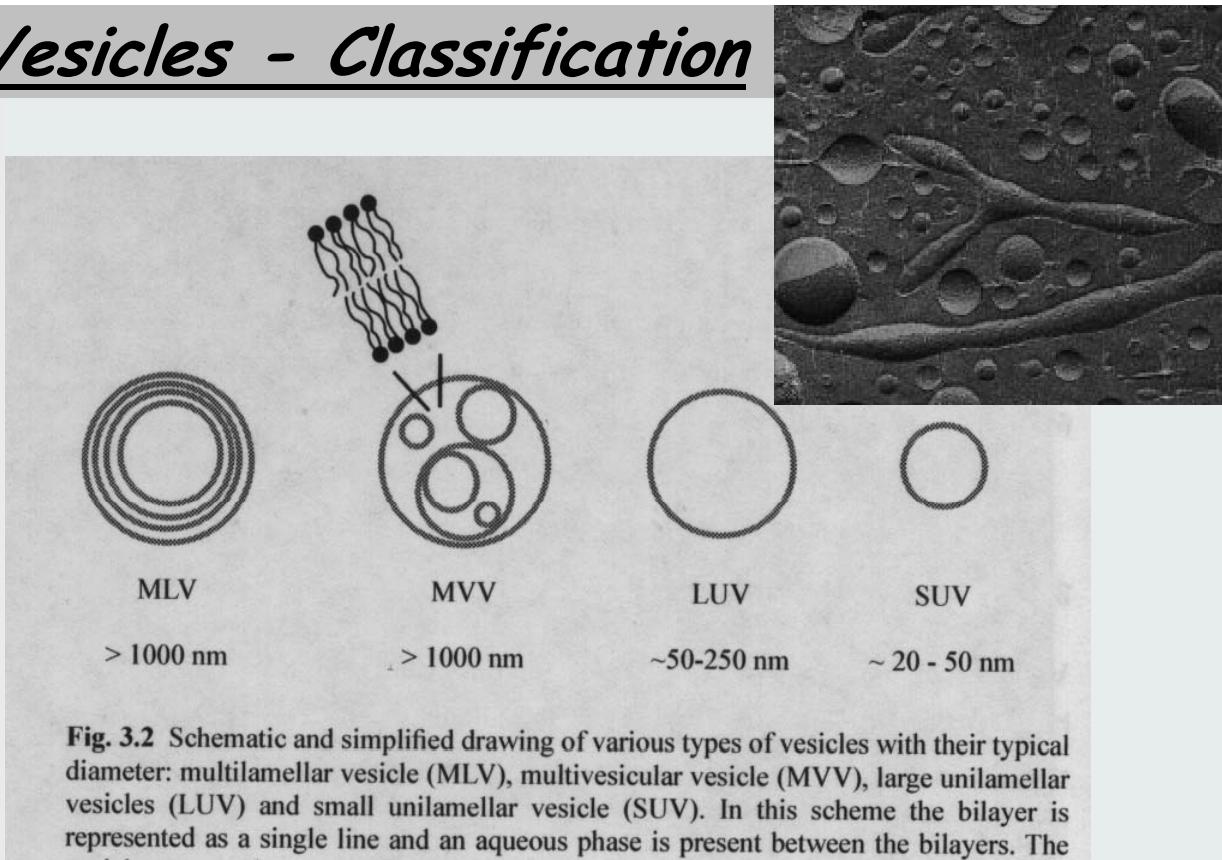


Fig. 3.2 Schematic and simplified drawing of various types of vesicles with their typical diameter: multilamellar vesicle (MLV), multivesicular vesicle (MVV), large unilamellar vesicles (LUV) and small unilamellar vesicle (SUV). In this scheme the bilayer is represented as a single line and an aqueous phase is present between the bilayers. The vesicles are not drawn to scale.

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Micelle and Vesicle Forms

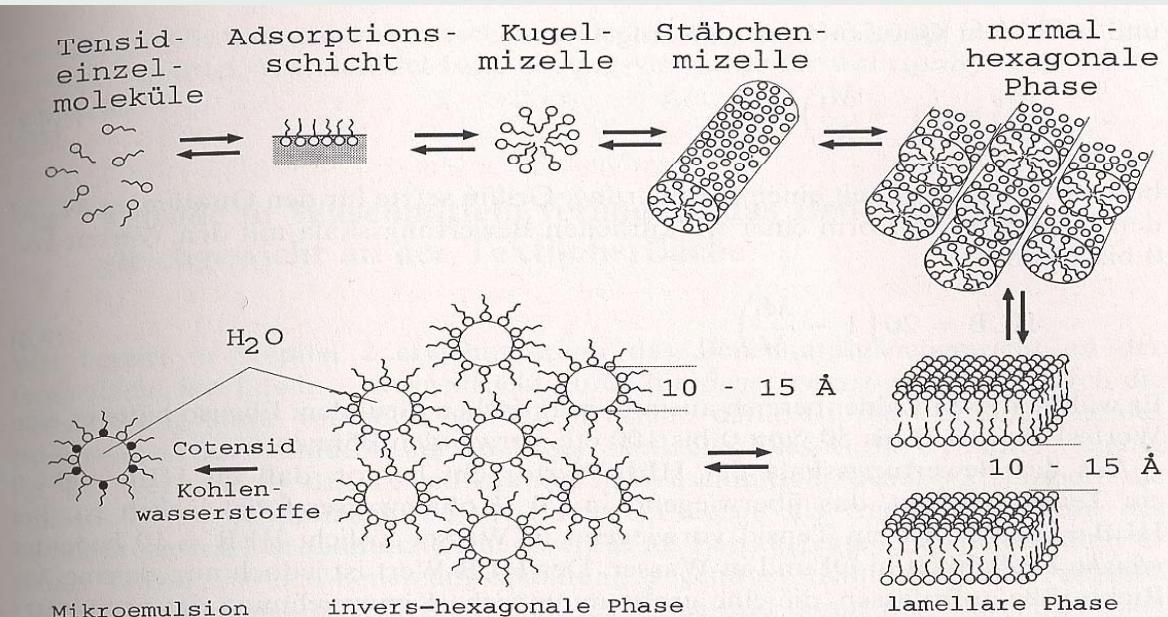


Abb. 7-2 Einzelschritte der Strukturbildung und Aggregationsformen in Tensidlösungen in Abhängigkeit von der Tensidkonzentration und/oder der Temperatur: Tensidsorptionsschichten, Kugelmizelle, Stäbchenmizelle, normalhexagonale Phase, lamellare Phase, invershexagonale Phase, Mikroemulsionen.

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Micelles – Microscopic Construction

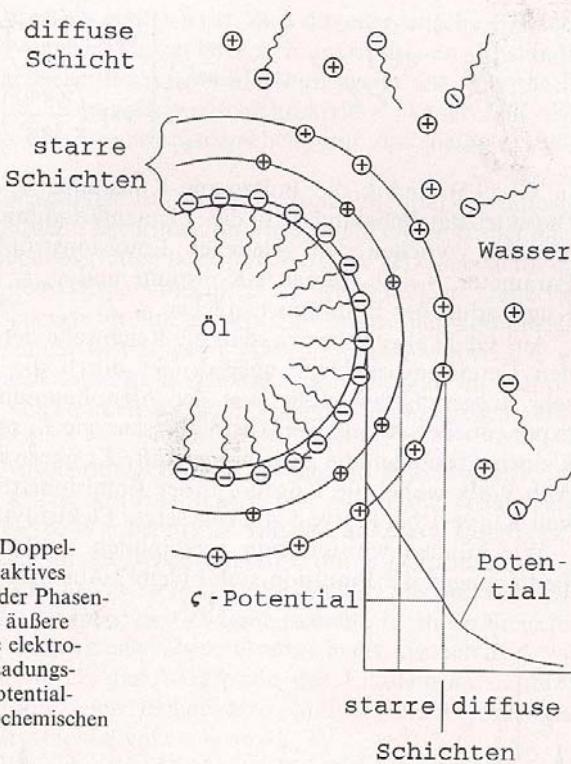


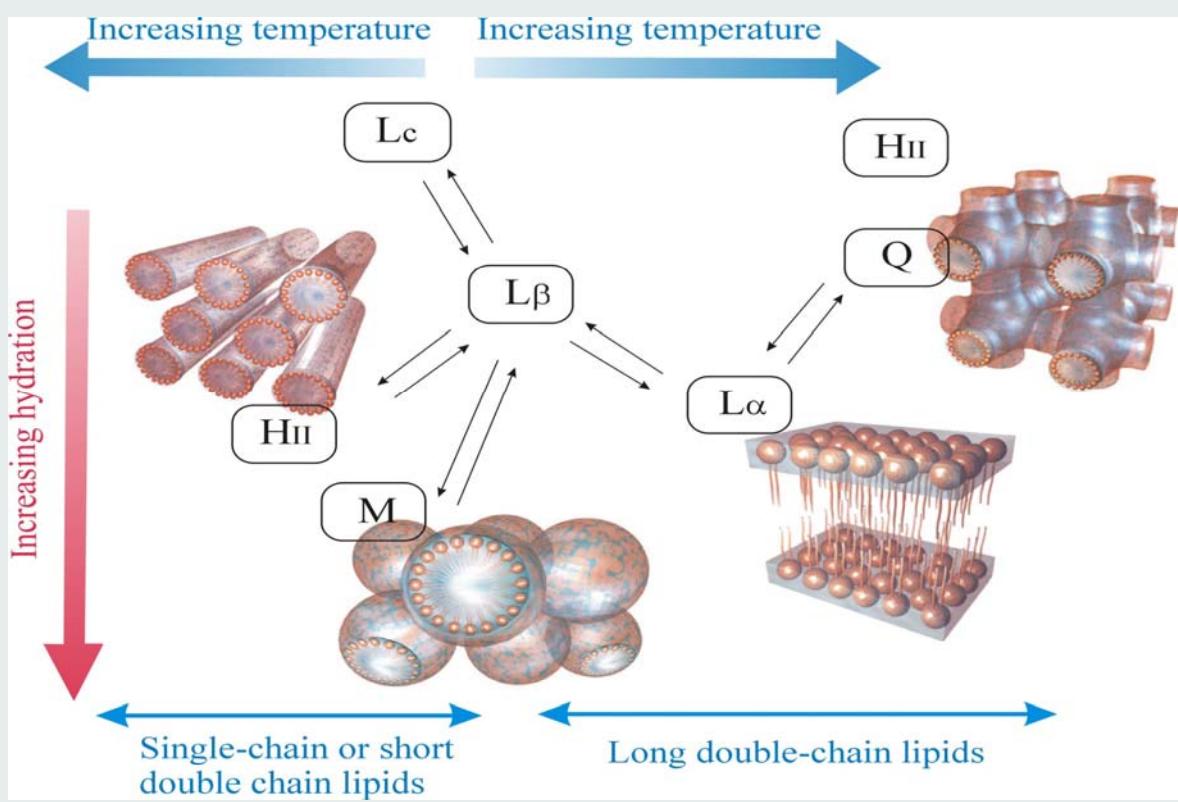
Abb. 9-7 Ladungsaufbau, das heißt Doppelschichtstruktur eines durch ein anionaktives Tensid stabilisierten Öltröpfchens an der Phasengrenze Öl/Wasser. An die innere und äußere starre Schicht schließt sich die diffuse elektrochemische Doppelschicht an. Diese Ladungsstruktur erzeugt einen spezifischen Potentialabfall in der Phasengrenze der elektrochemischen Doppelschicht Öl/Wasser.

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Bilayer Arrangements in Space

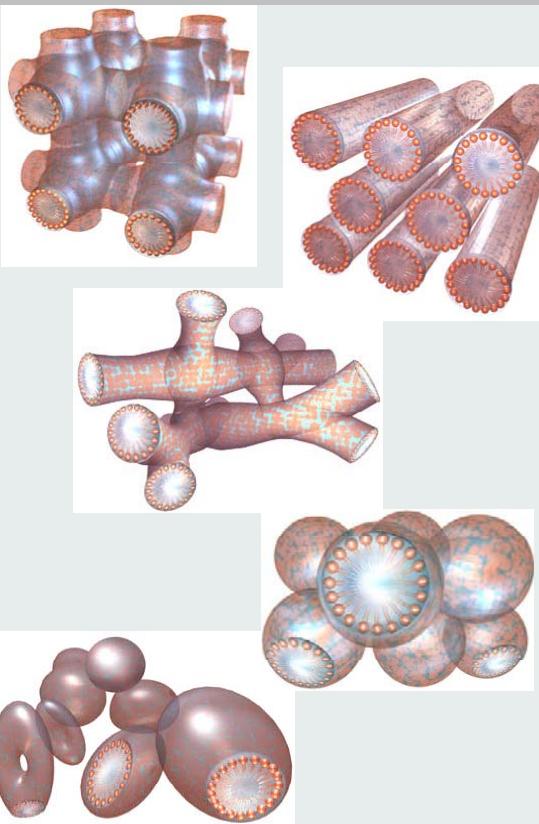


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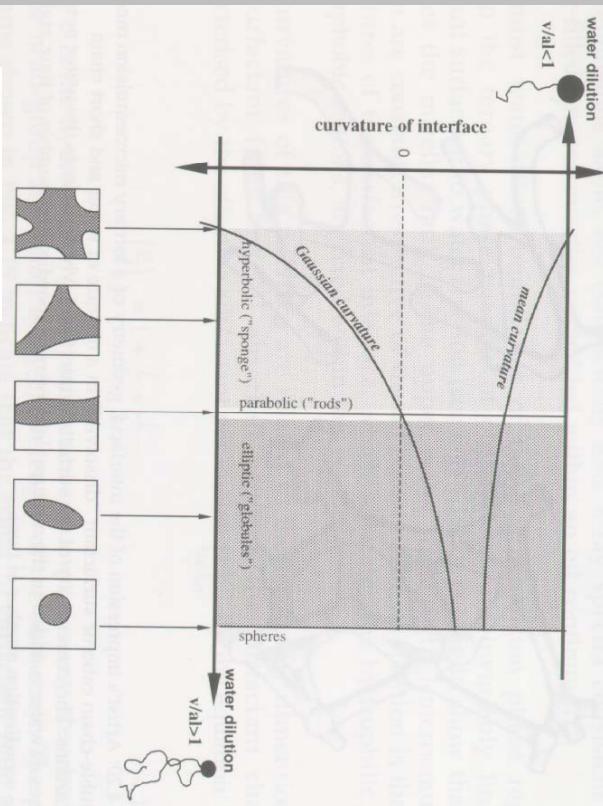
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Template / Tenside Solutions



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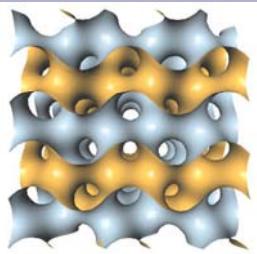
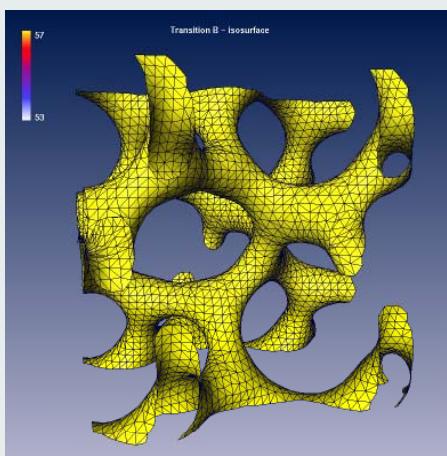


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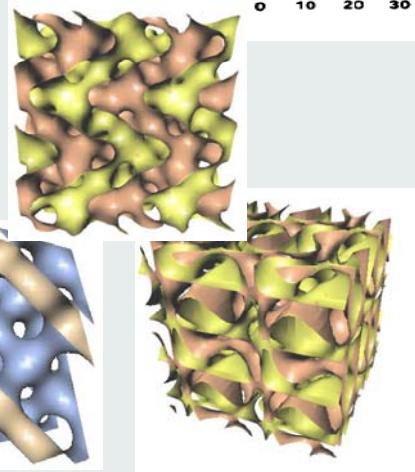
19



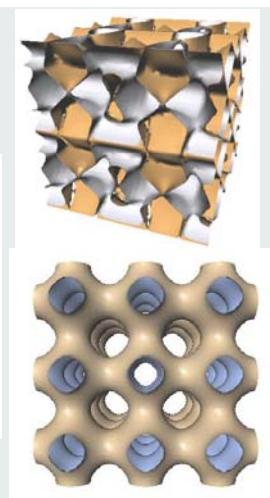
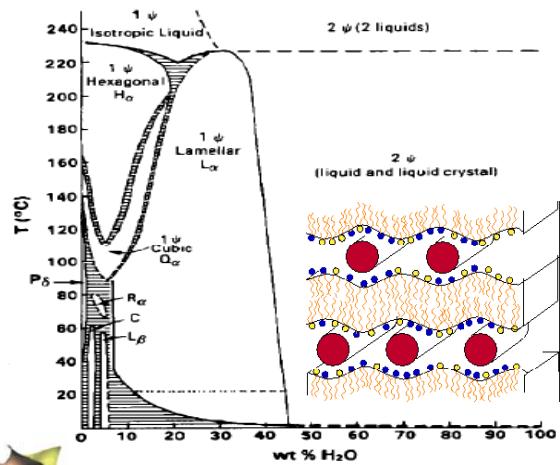
Liquid Crystal Structures 3D-Structures



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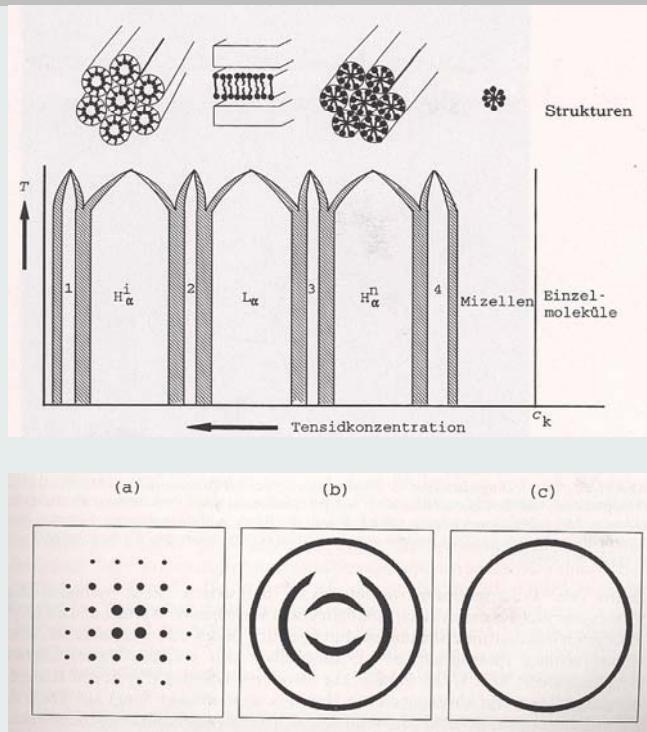
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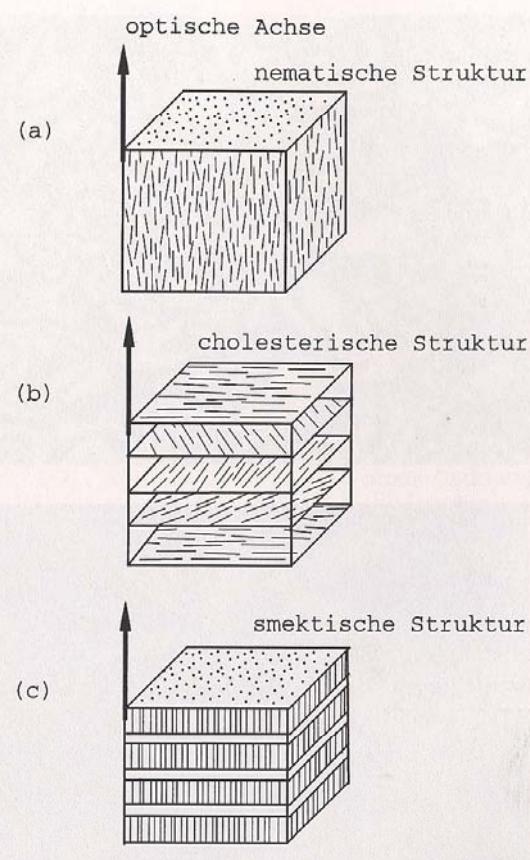
Liquid Crystal Structures



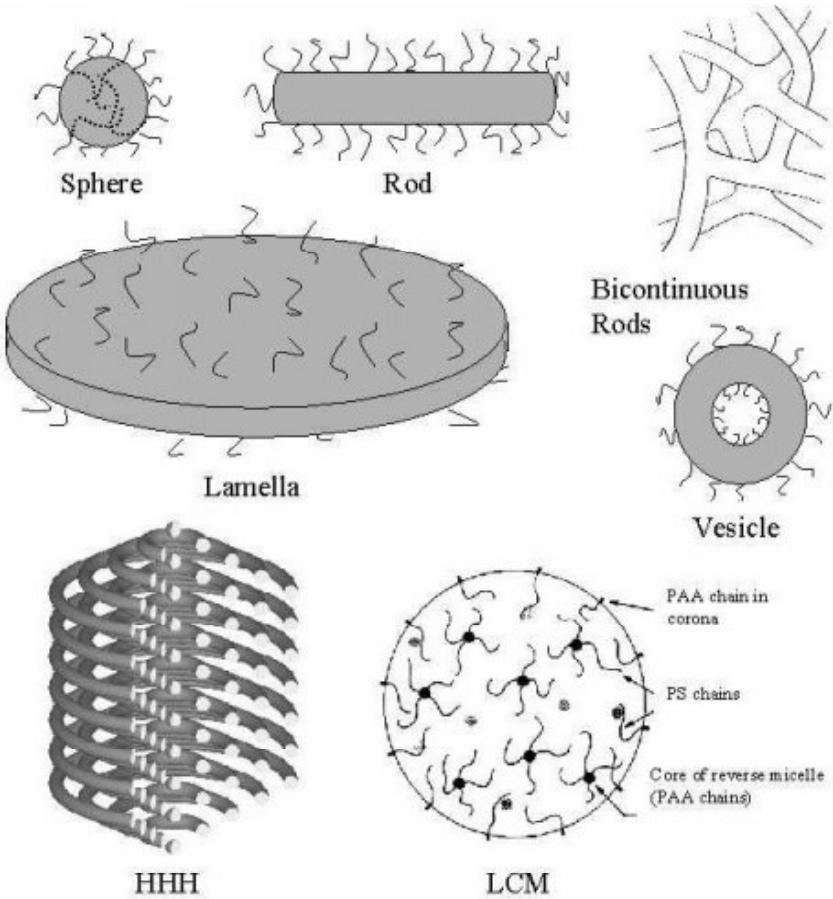
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Overview General Forms

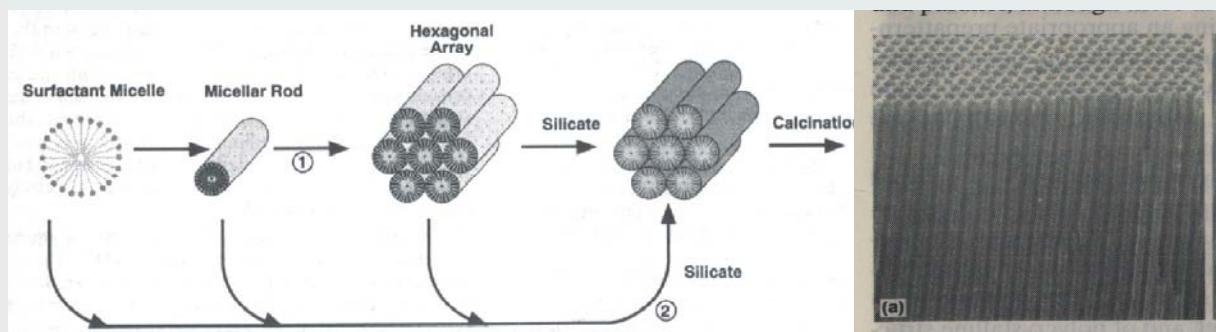


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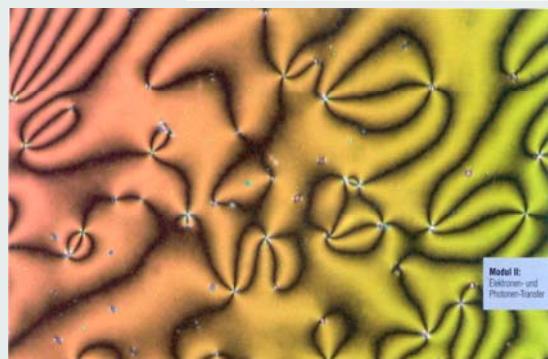
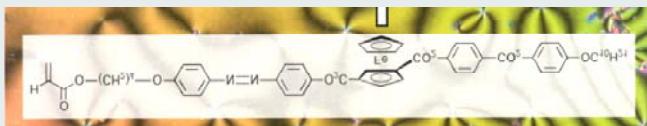
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Mesoporous Silicates: MCM41 / MCM48



Liquid crystal systems



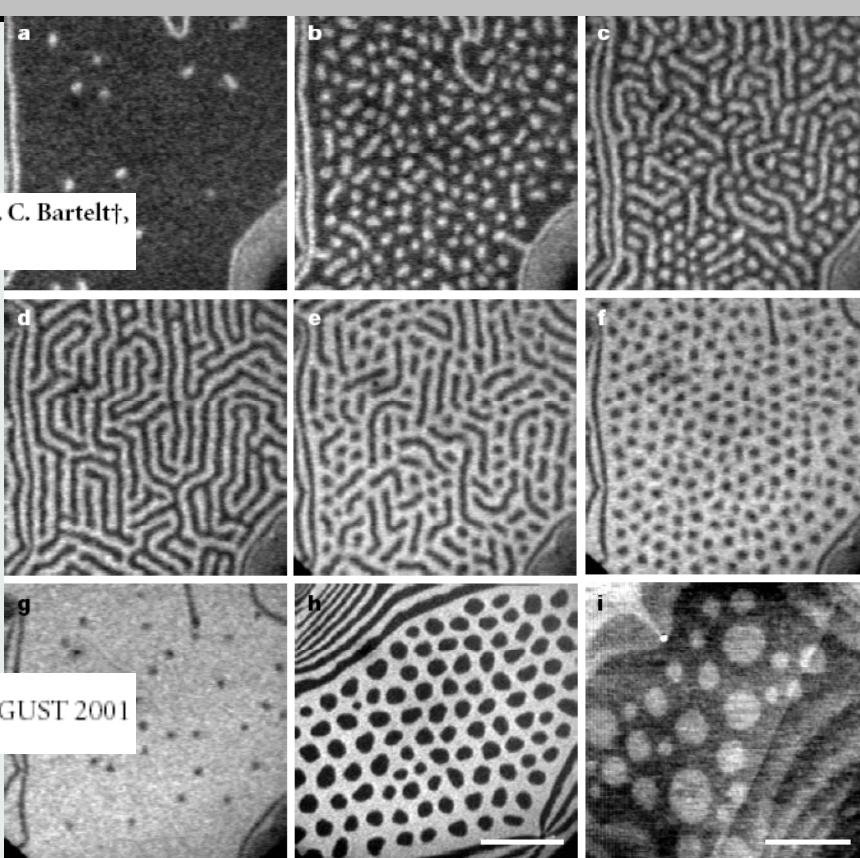
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Selfassembled Domain Patterns

Richard Plass*, Julie A. Last*, N. C. Bartelt†,
G. L. Kellogg*



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Multi Component Systems

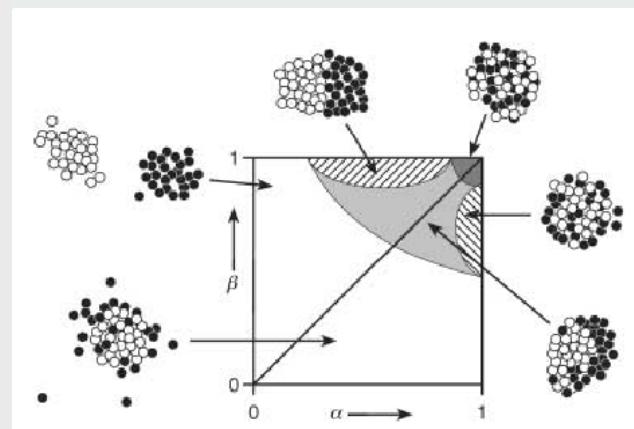


Abbildung 7. „Morphologiediagramm“ von Zwei-Komponenten-Clustern, wobei α die Stärke der Wechselwirkung zwischen den beiden („schwarzen“ und „weißen“) Partikeln und β die Stärke der Kohäsion zwischen den „weißen“ Partikeln im Vergleich zum entsprechenden Wert der „schwarzen“ Partikel ist (nach Lit. [48], Copyright® American Institute of Physics, 1994).

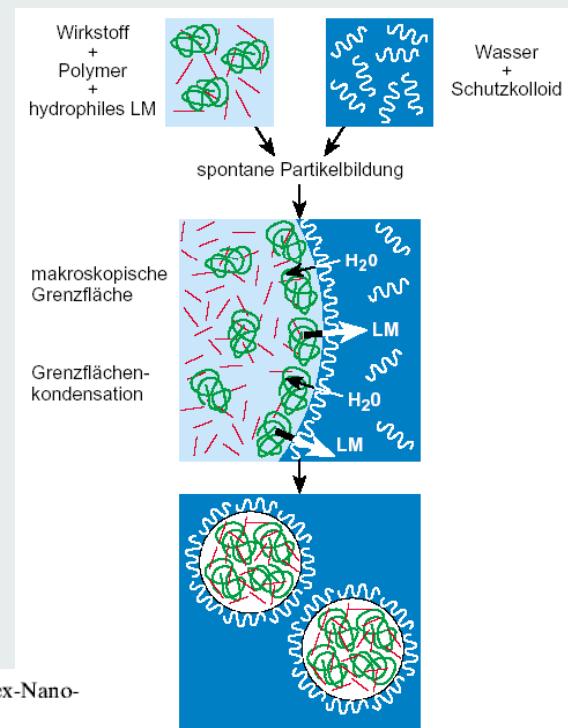


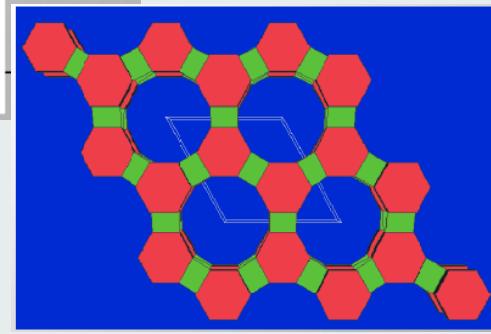
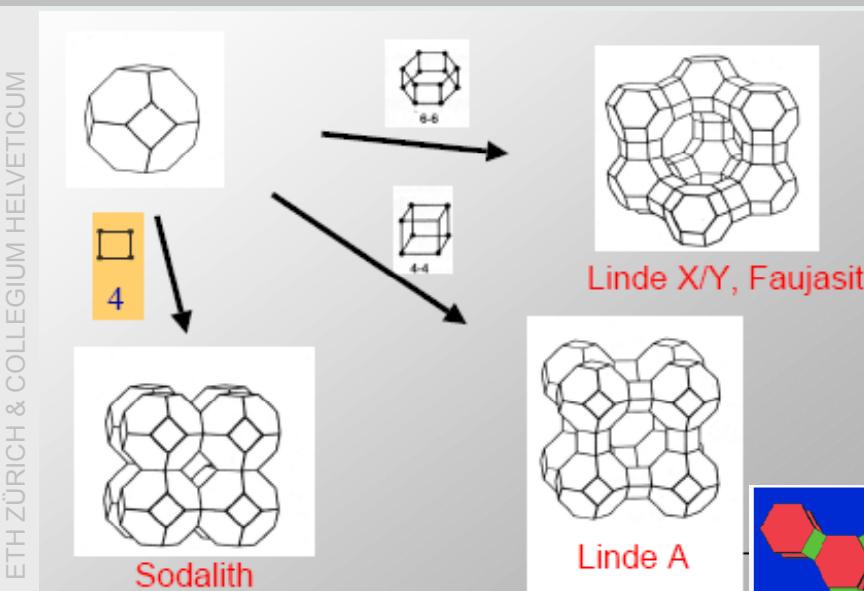
Abbildung 14. Prinzip der Herstellung von Wirkstoff/Pseudolatex-Nanopartikeln durch Grenzflächenkondensation.

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Zeolites



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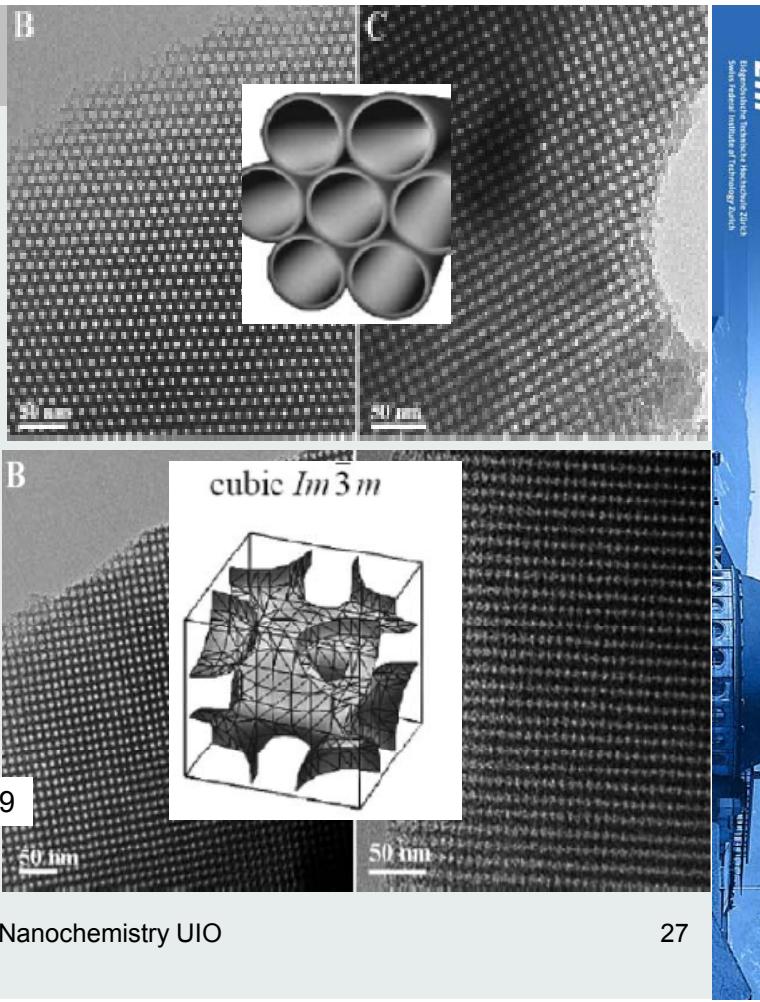
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Mesoporous

The body-centered cubic ($Im\text{-}3m$) mesostructured silica (S2) 0.80 g F127 and 0.084 g AOT were dissolved in a mixture of 31.0 g water and 9.0 g H_2SO_4 (2.0 M) at 45 uC to obtain a clear solution. After 3.80 g TEOS was added to the solution under vigorous stirring, the mixture was continuously stirred at 45 °C for 1 day. The precipitate together with the solution was transferred into a Teflon autoclave and then heated at 100 °C for 24 h.

J. Mater. Chem., 2006, 16, 1511–1519



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