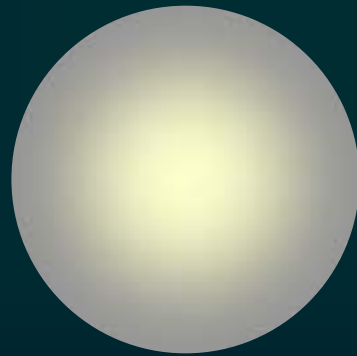


第20回NAIST産学連携フォーラム「光ナノサイエンスの最前線」  
(2008.10.30, 大阪)

# 光に応答する人工細胞



奈良先端科学技術大学院大学  
物質創成科学研究科

菊池純一

NAIST



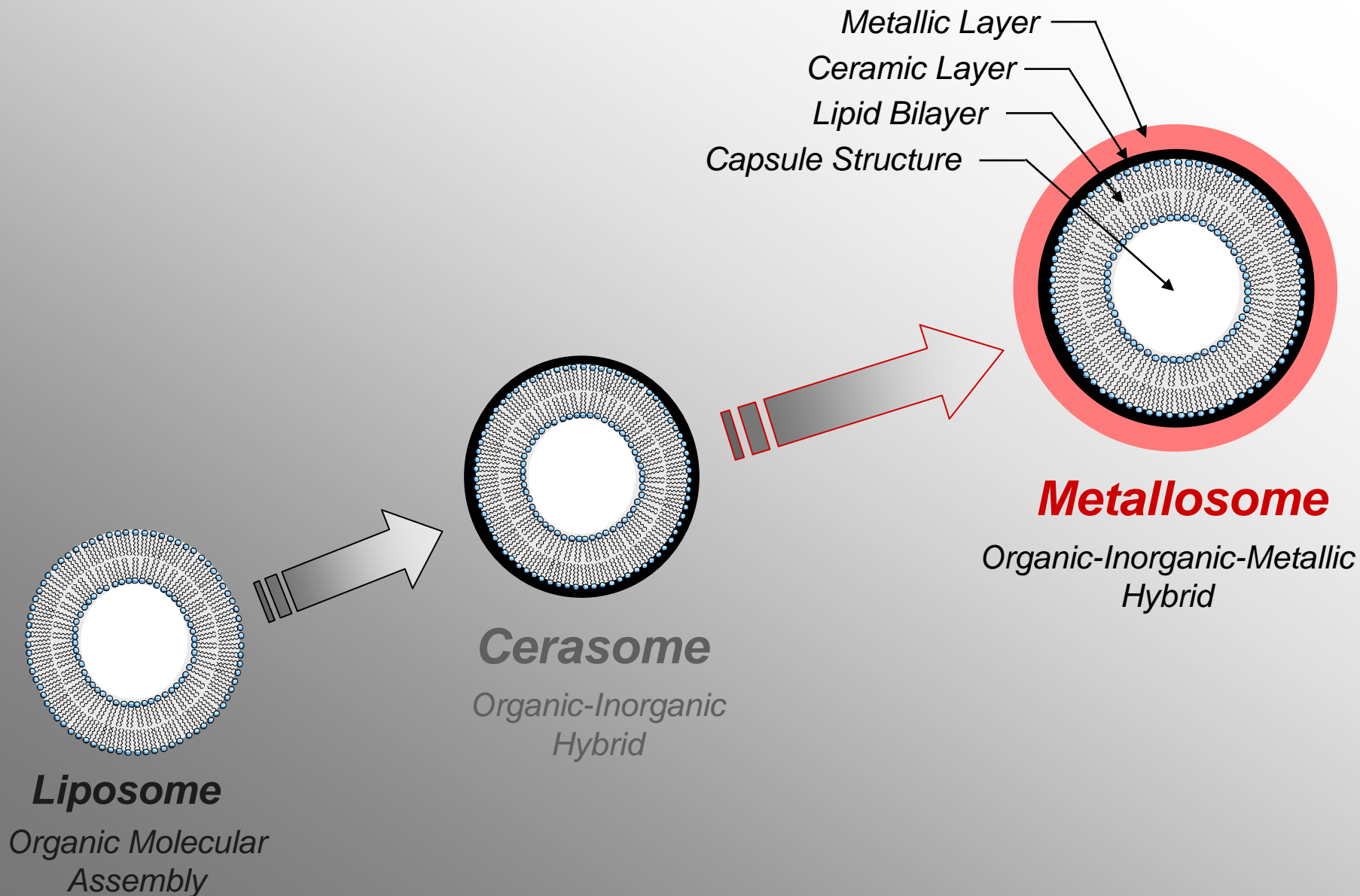
# 講演内容

1. 人工細胞膜とその利用
2. 有機 - 無機ナノハイブリッド 「セラソーム」
3. 有機 - 無機 - 金属ナノハイブリッド 「メタロソーム」
4. 「分子通信」 物質 - バイオ - 情報分野の融合

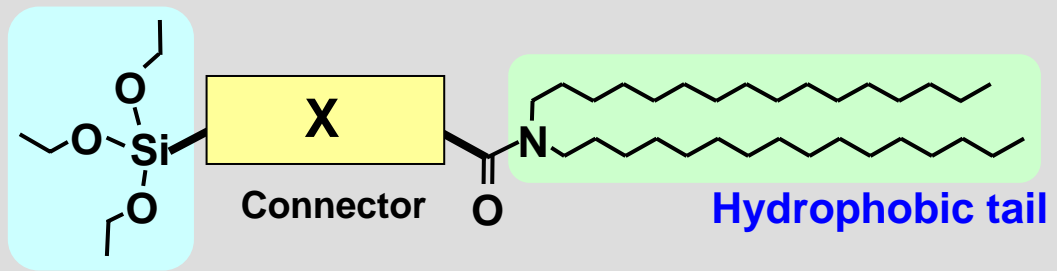
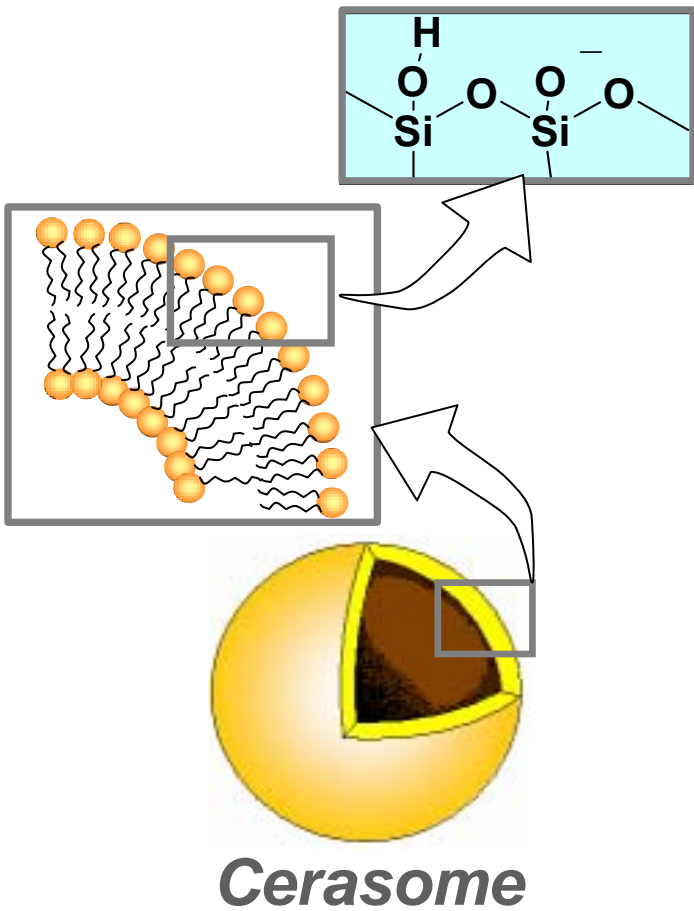
# 人工細胞膜： 応用分野の可能性

1. 医療： DDS、 遺伝子キャリアーなど
2. 化粧品
3. 分子機能材料
4. 分子デバイス
5. 未来の情報通信システム

# リポソームからセラソーム、そしてメタロソームへ

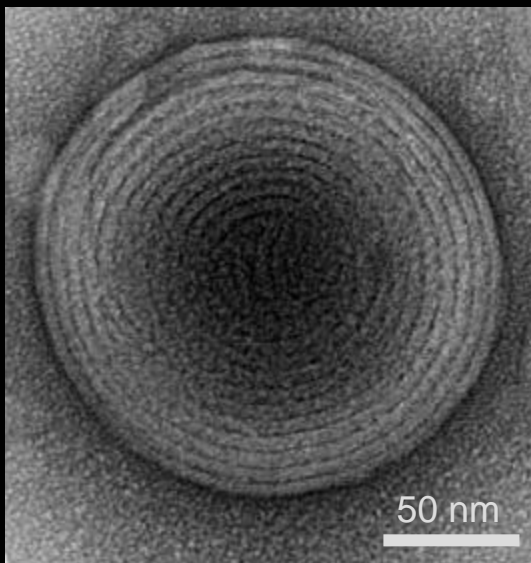


# セラソームの設計

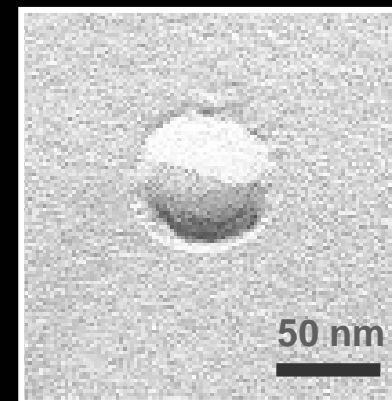
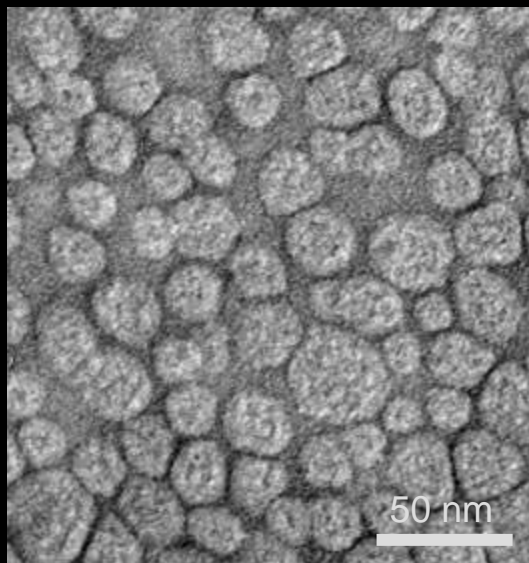


- 1: X =
- 2: X =
- 3: X =
- 4: X =
- 5: X =

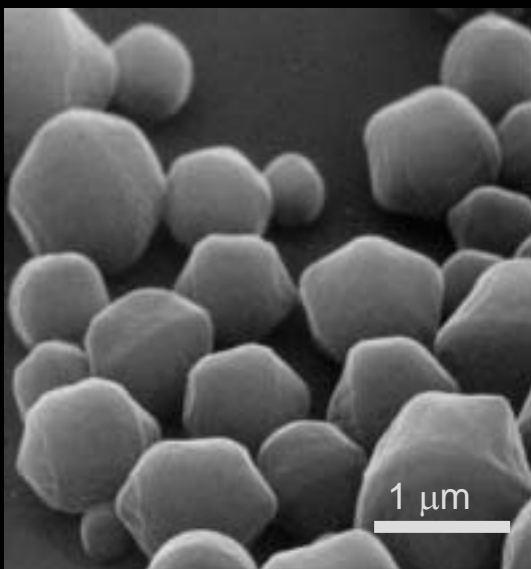
# セラソームの構造



*TEM (negative staining)*



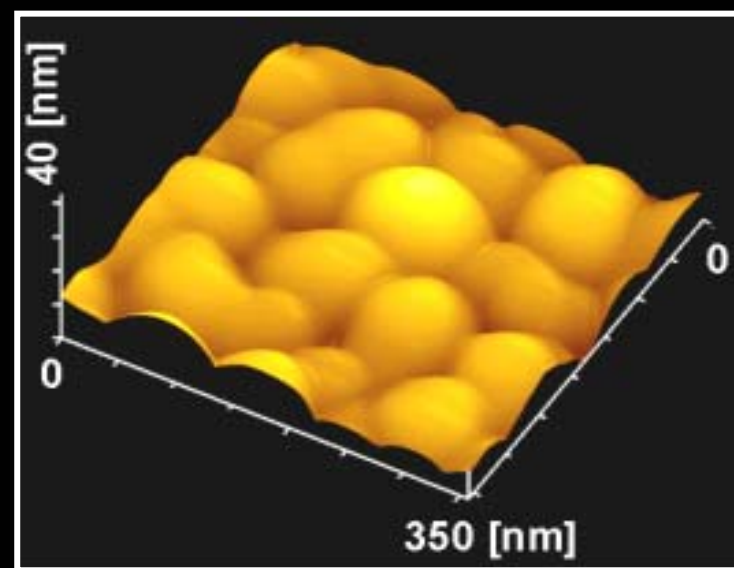
*TEM (freeze-fracture)*



*SEM*



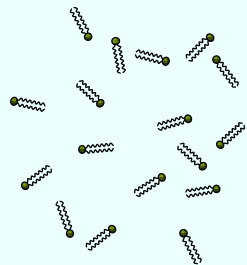
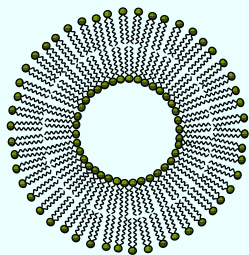
*Optical Micrograph*



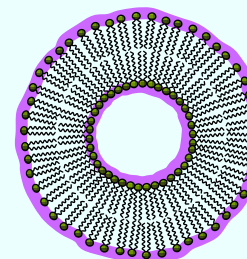
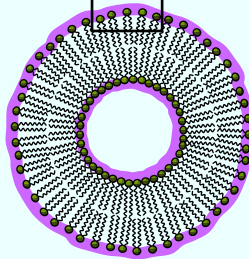
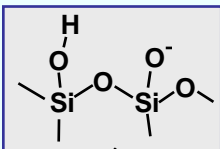
*AFM*

# セラソームの物性: 高強度

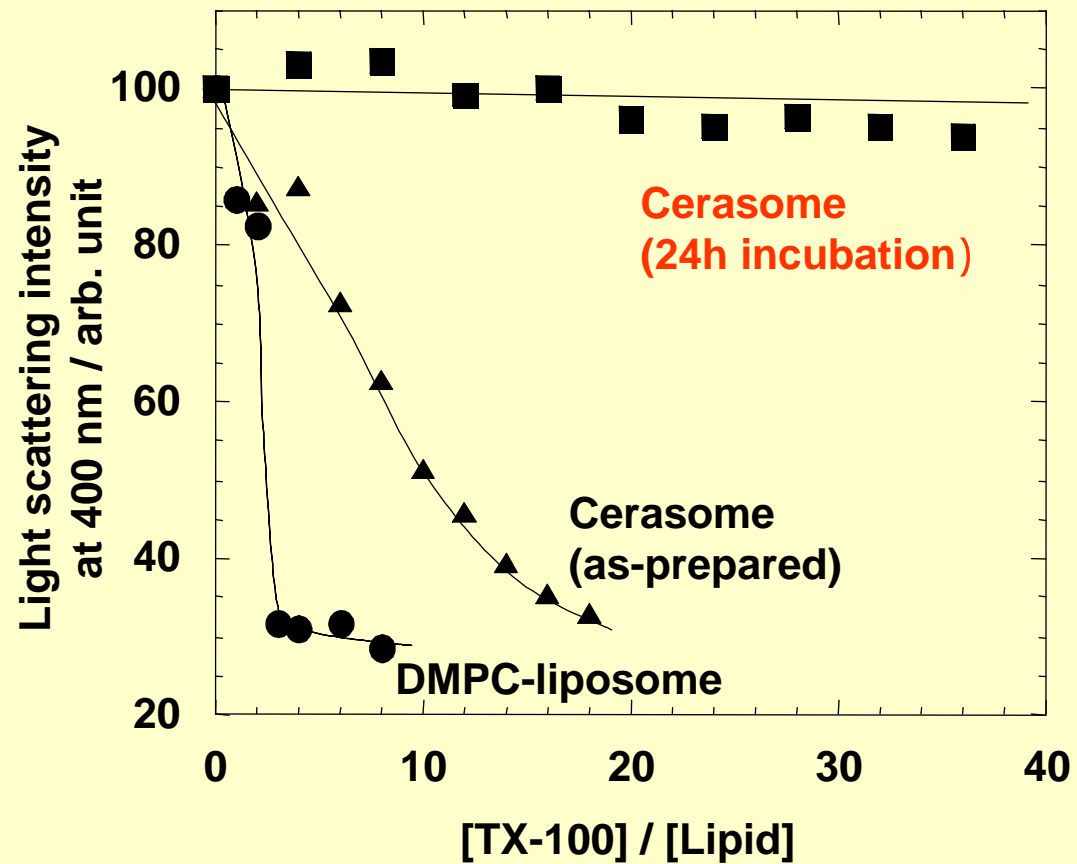
DMPC Liposome



Triton X-100  
(TX-100)

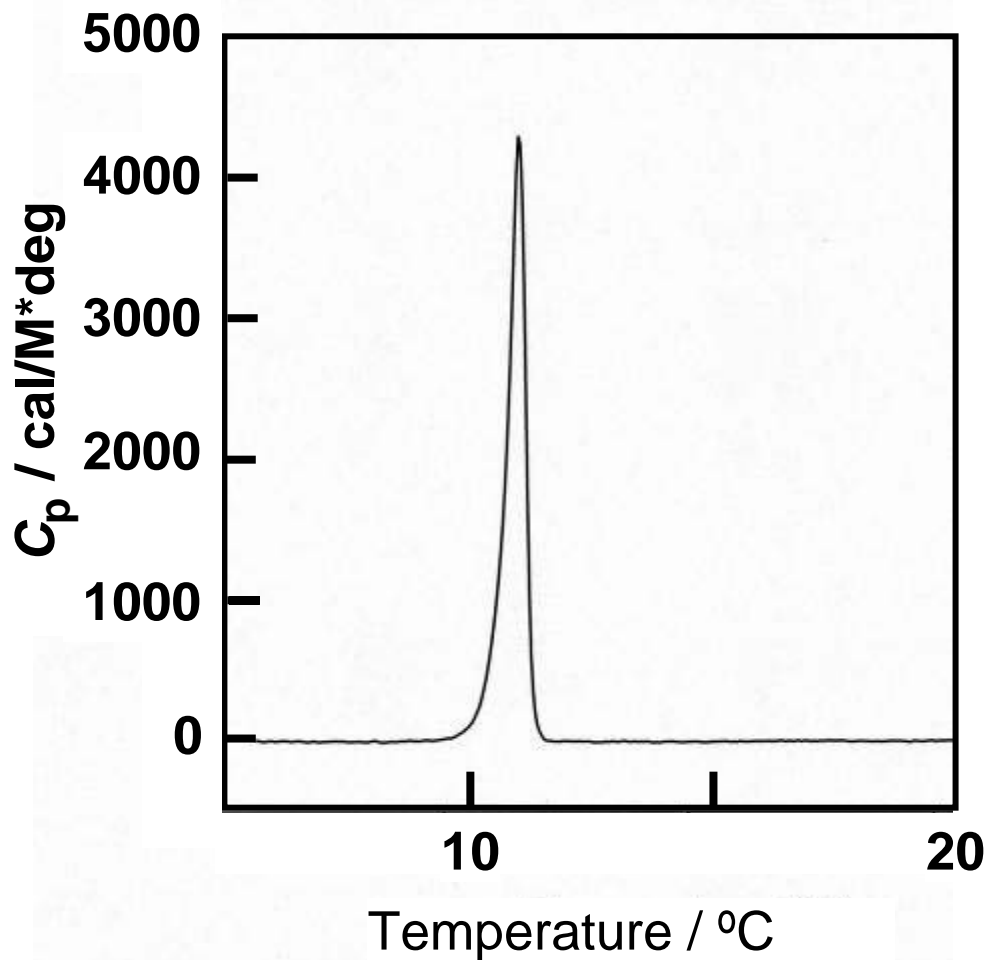


Cerasome 1

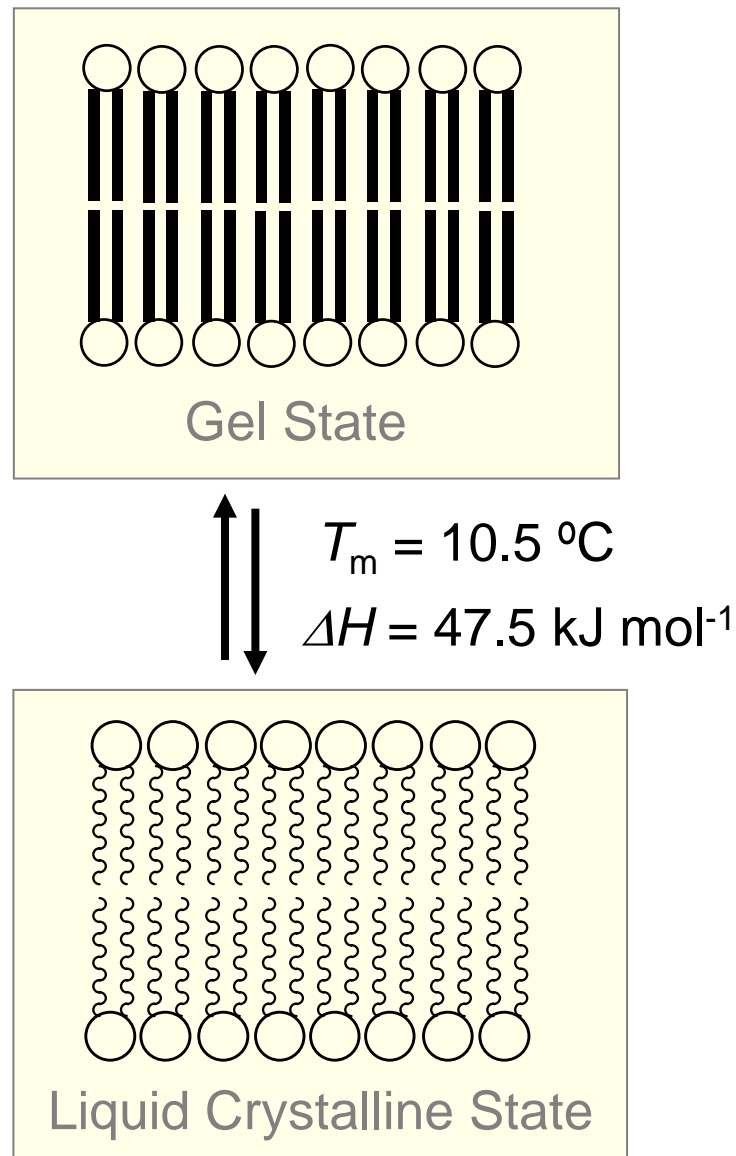


[Lipid] = 0.1 mM, 30

# セラソームの物性: ゲル - 液晶相転移挙動

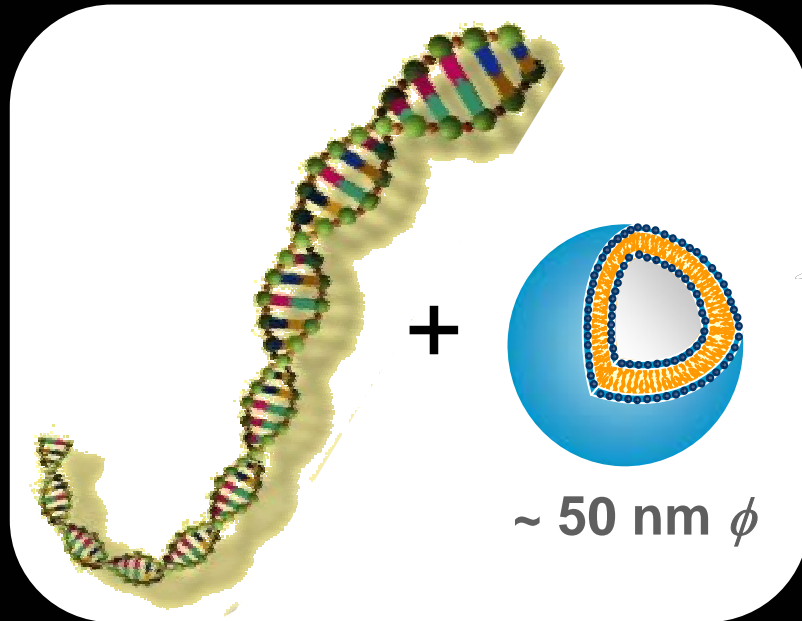


[Cerasome-forming lipid] = 0.5 mM





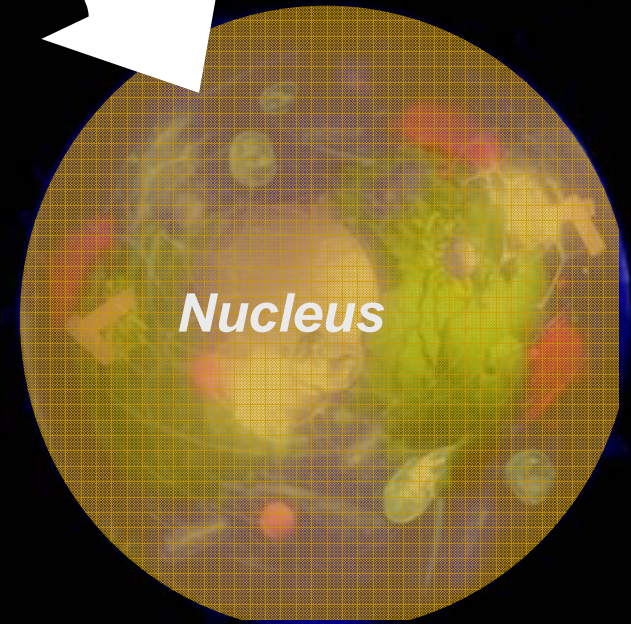
# セラソームの機能: 細胞にやさしい遺伝子キャリアー



**Cationic liposome-DNA complex**

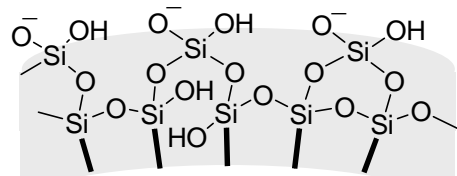
*Lipofectamine*  
*Lipofectin*  
*Peptide lipid*  
*Cerasome*

**Transfection**

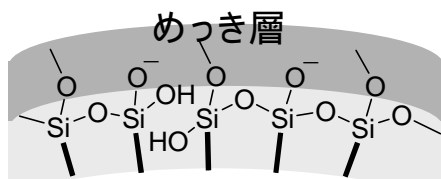


**Cell**

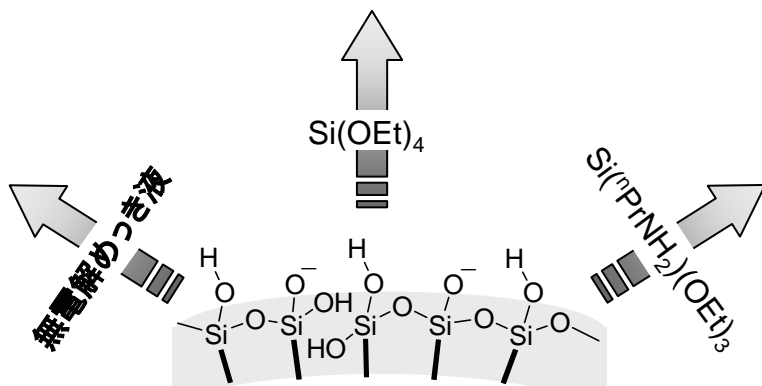
# セラゾームの機能：表面機能化の多様性



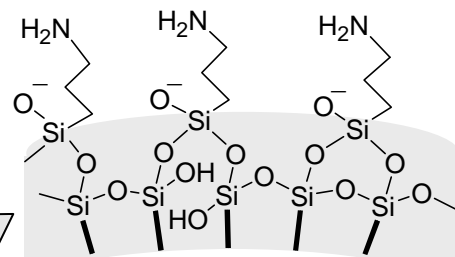
(a) シロキサンネットワークの強化



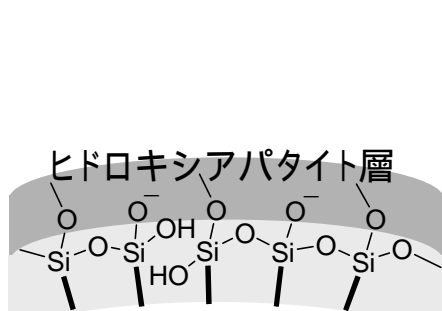
(e) 無電解めっきによる  
金属被覆



セラゾーム



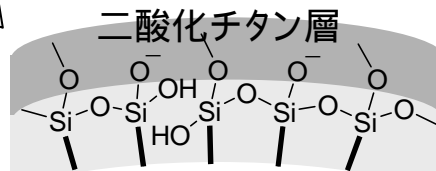
(b) 有機官能基の導入



(d) ヒドロキシアパタイト層  
による被覆

擬似体液

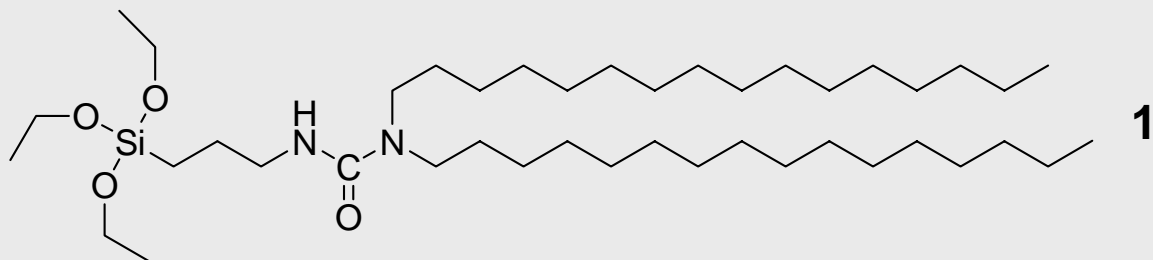
$\text{Ti}(\text{O}^n\text{Bu})_4$



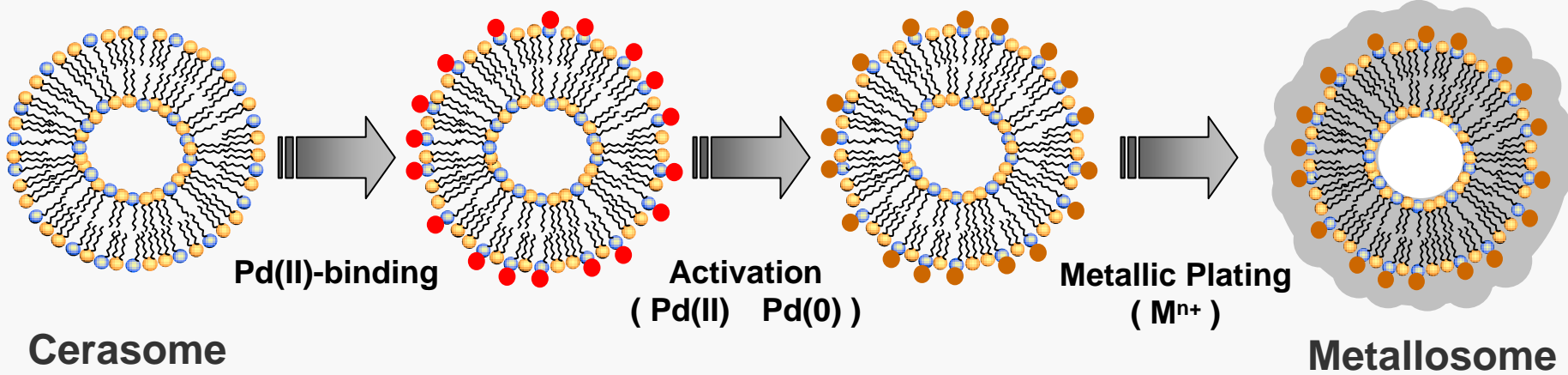
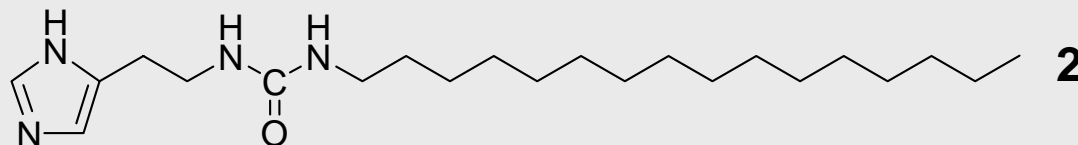
(c) 光触媒機能の付与

# メタロソームの設計

Cerasome-forming Lipid

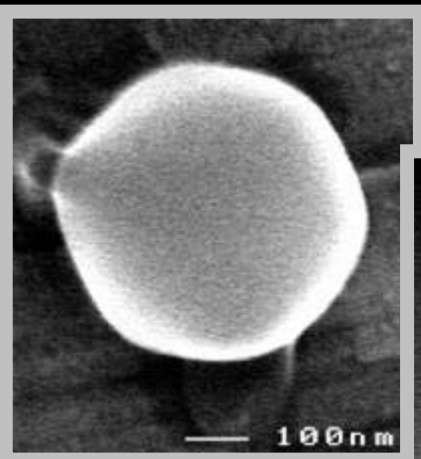


Hydrophobized Ligand

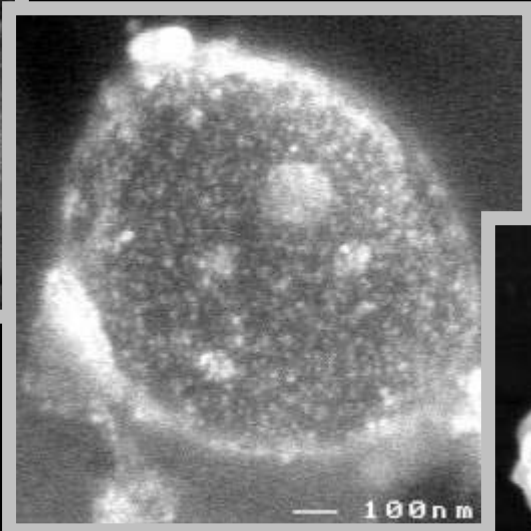


( [1] : [2] = 90 : 10 ~ 99.9 : 0.1 )

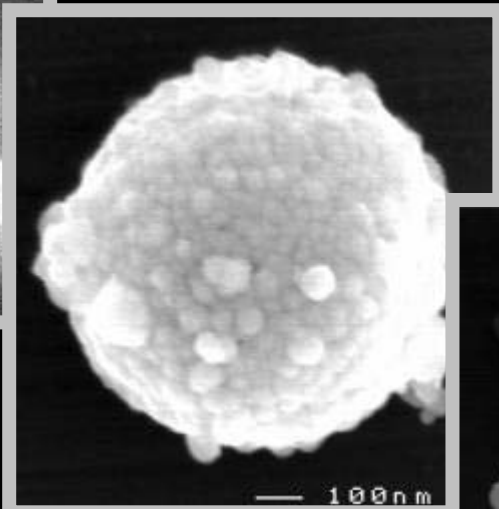
# メタロソームの作製



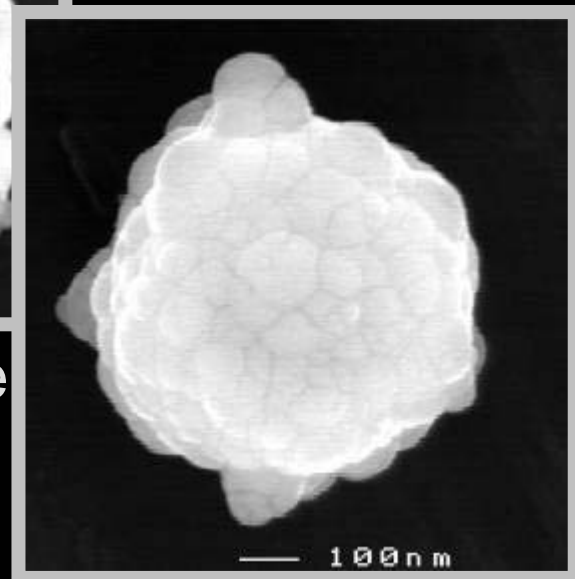
Cerasome



Ni-Metallosome  
(after 3 min)



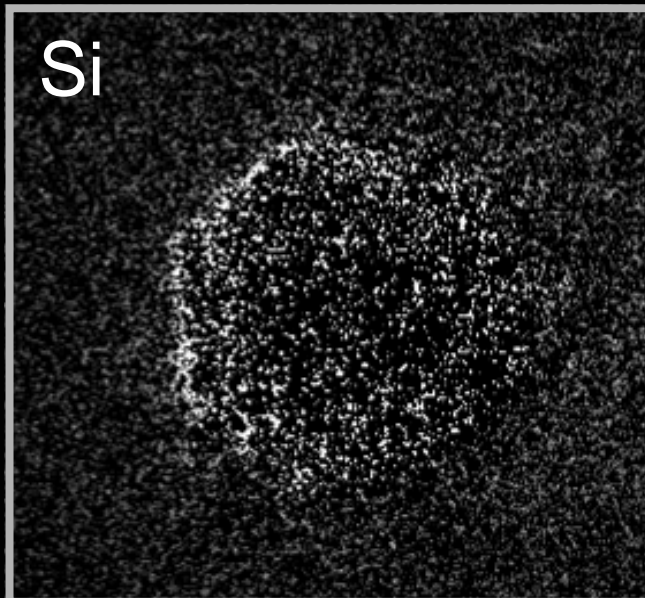
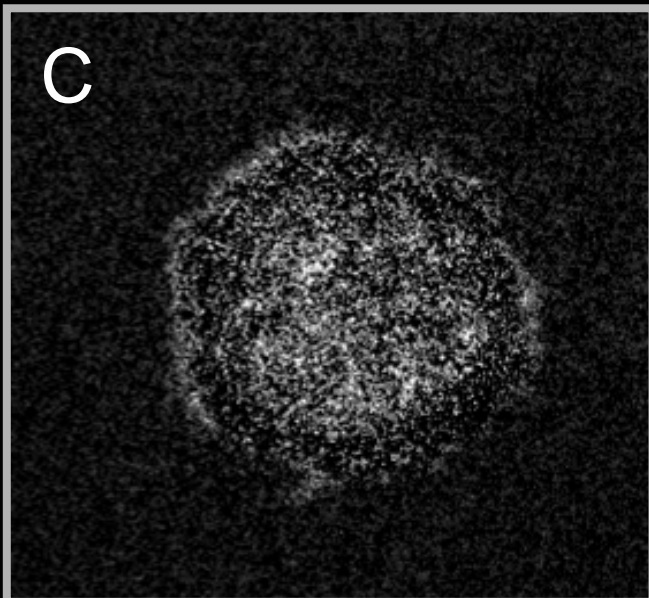
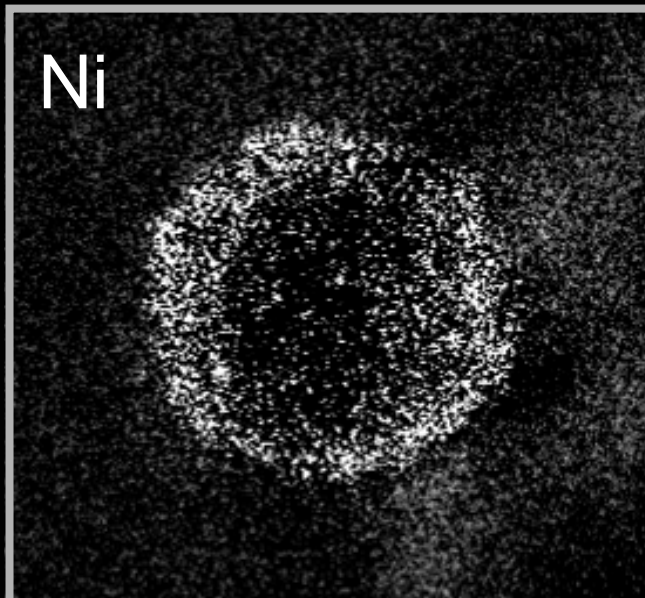
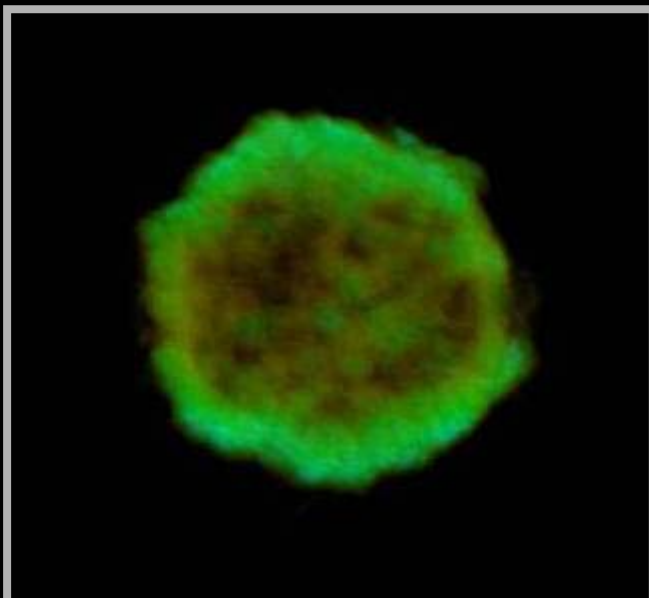
Ni-Metallosome  
(after 4 min)



Ni-Metallosome  
(after 5 min)

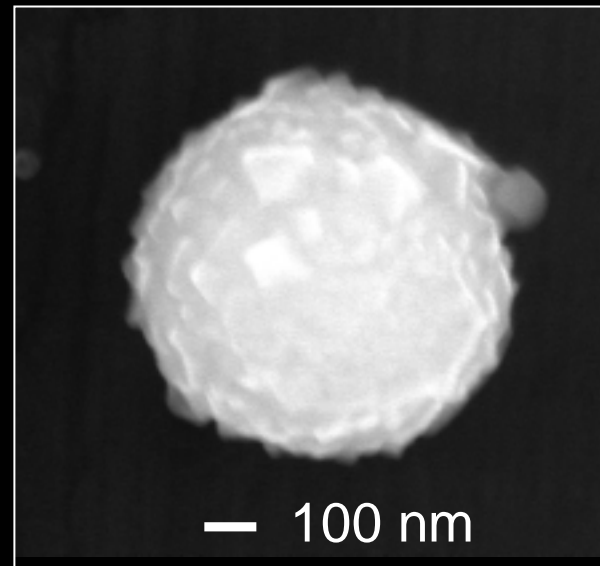
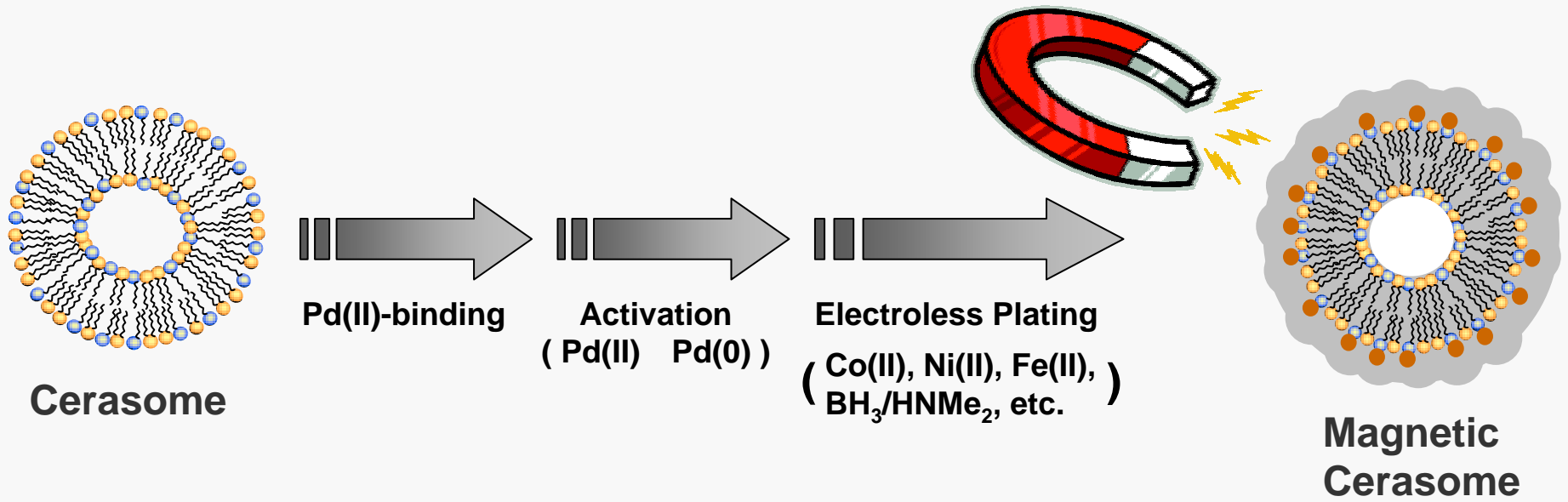
Electroless plating

# メタロソームの構造：透過型電子顕微鏡像



Elemental Mapping by EELS (Electron Energy-Loss Spectroscopy)

# メタロソームの機能：磁気マニピュレーション

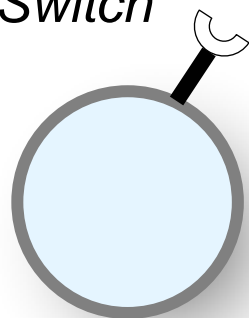


# 光に応答する分子通信システム

Propagation

Amplification

Molecular  
Switch

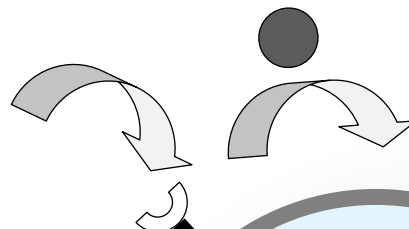


Molecular  
Capsule

$h\nu$



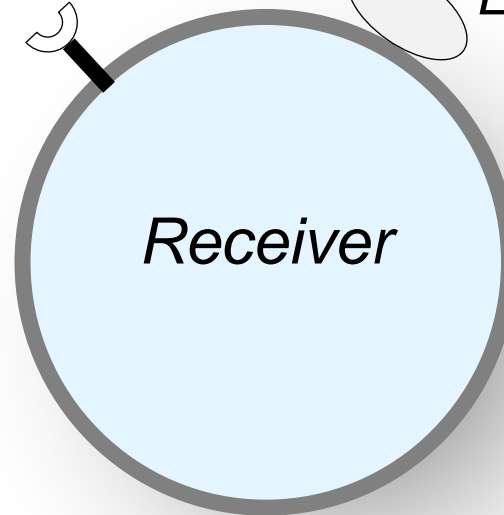
Mediator



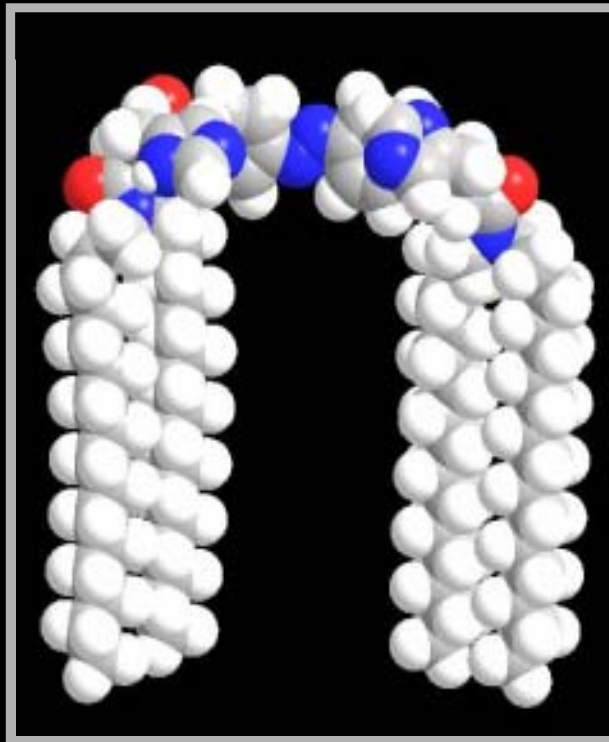
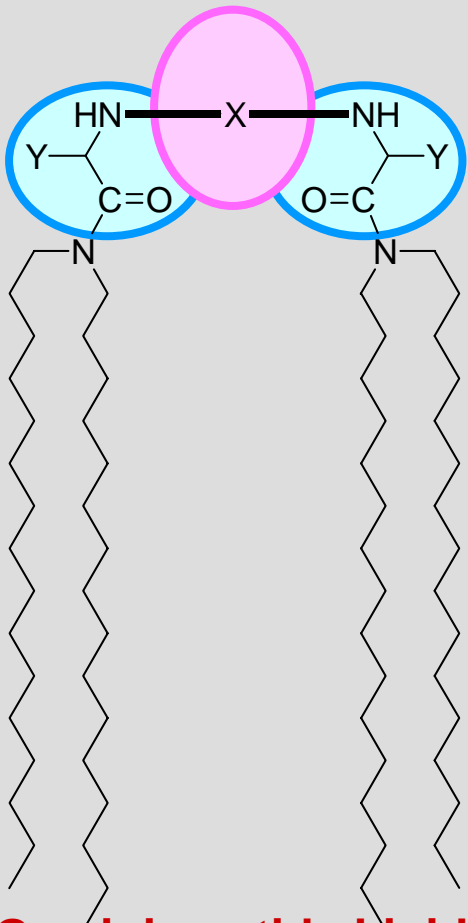
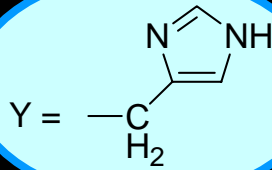
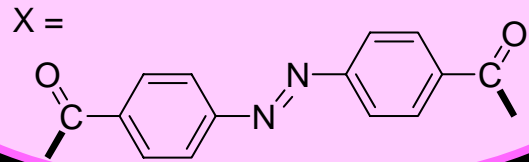
Enzyme



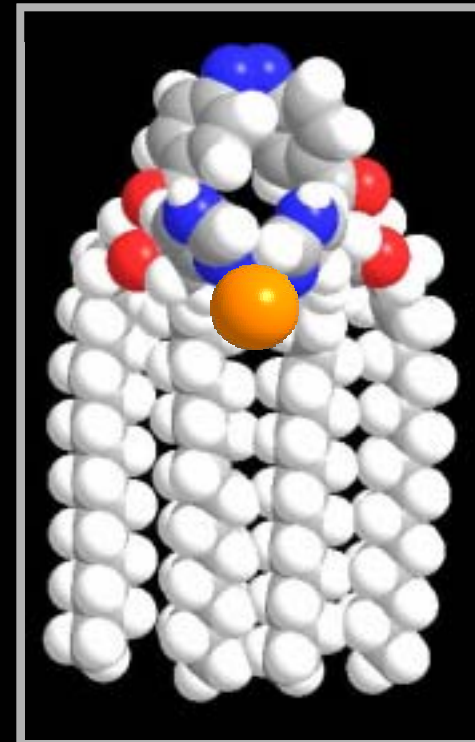
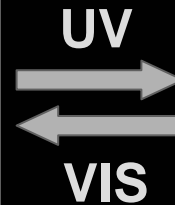
Receiver



# 分子スイッチの設計



*trans*-form

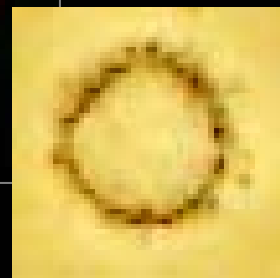
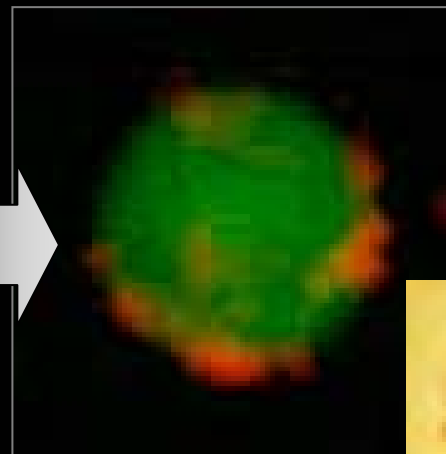
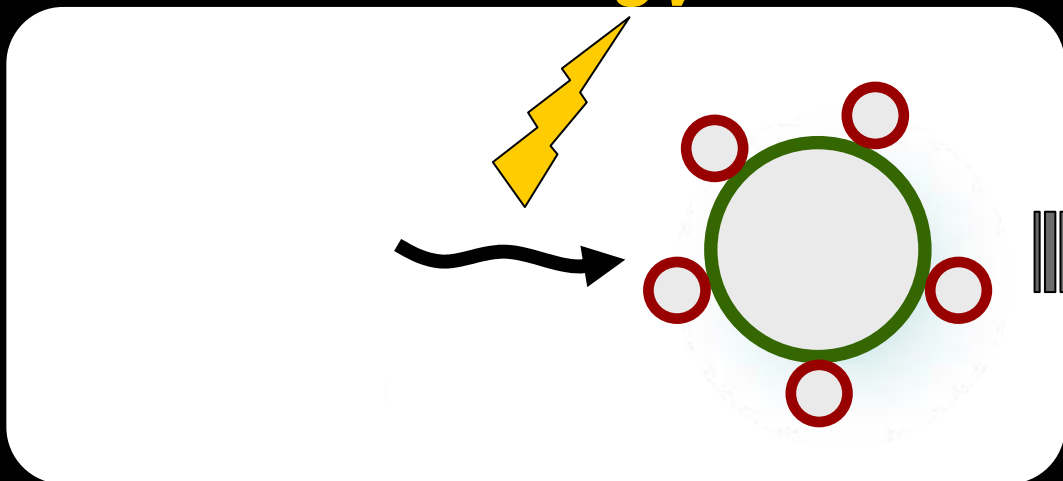


*cis*-form

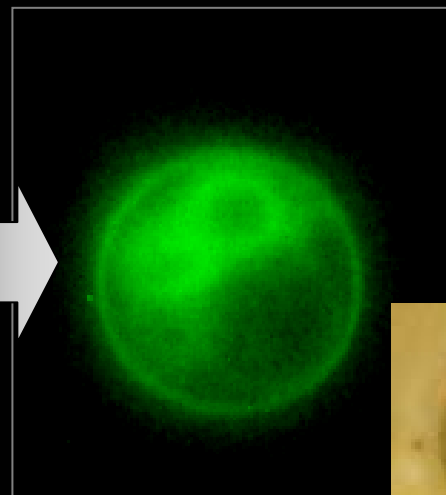
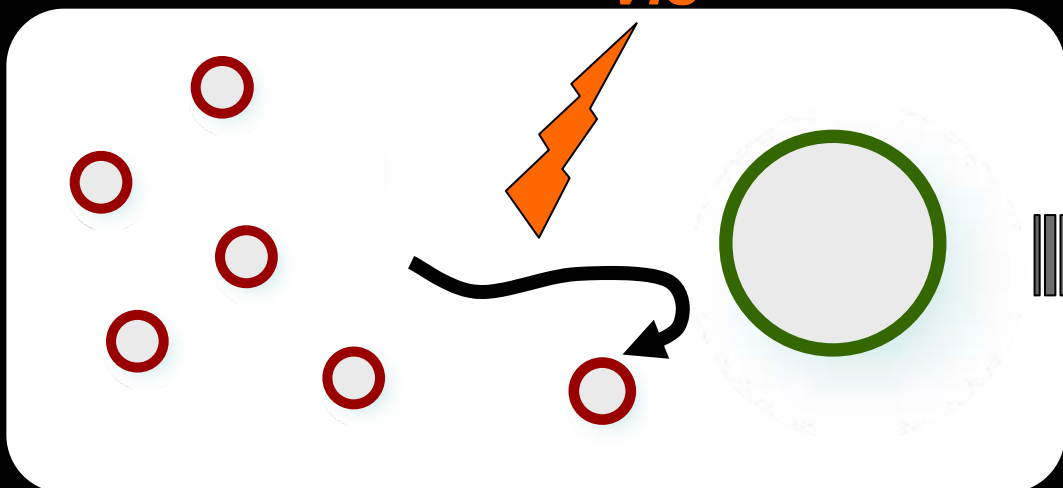


# 分子カプセル伝搬の光マニピュレーション

UV

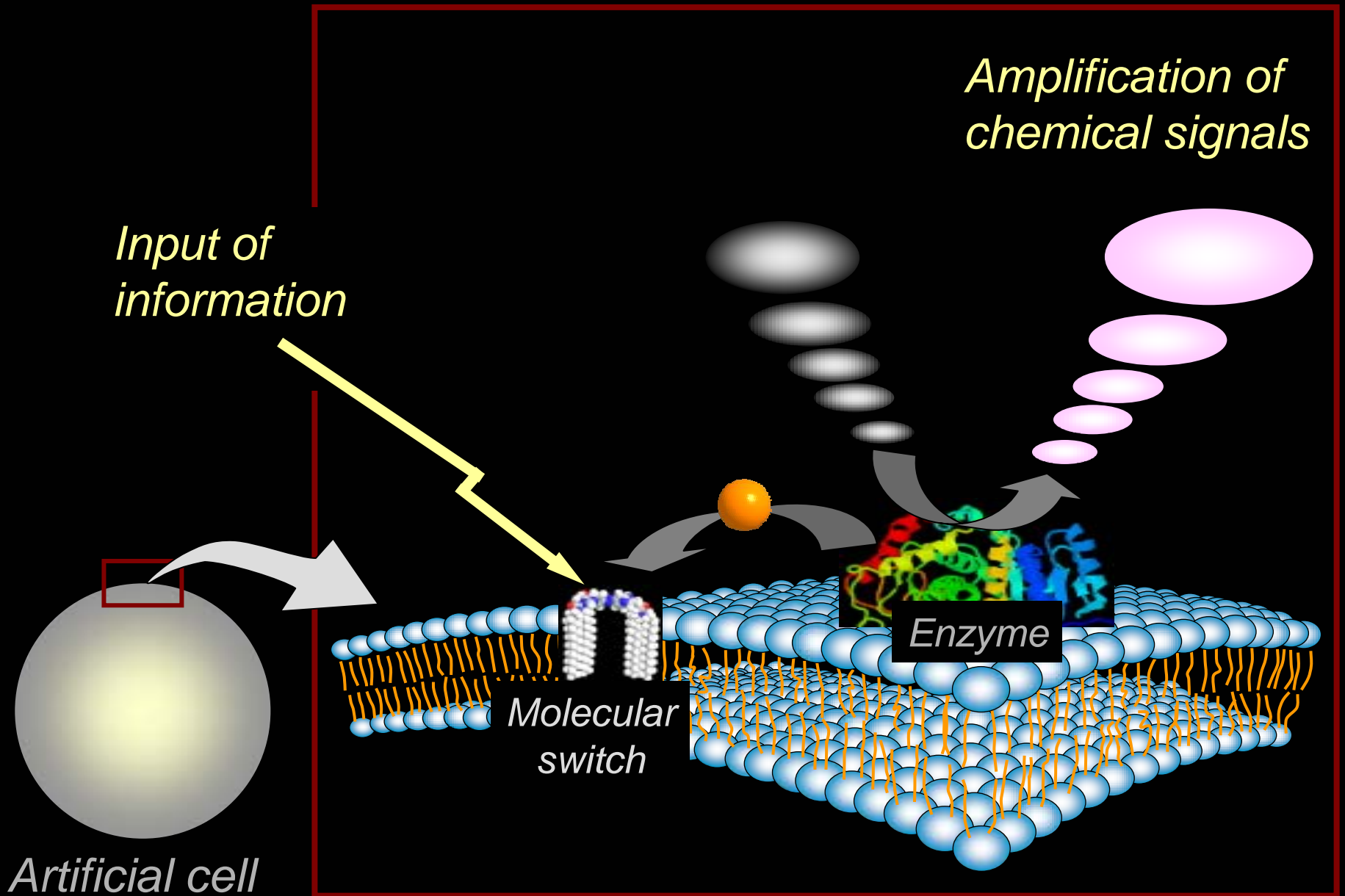


Vis

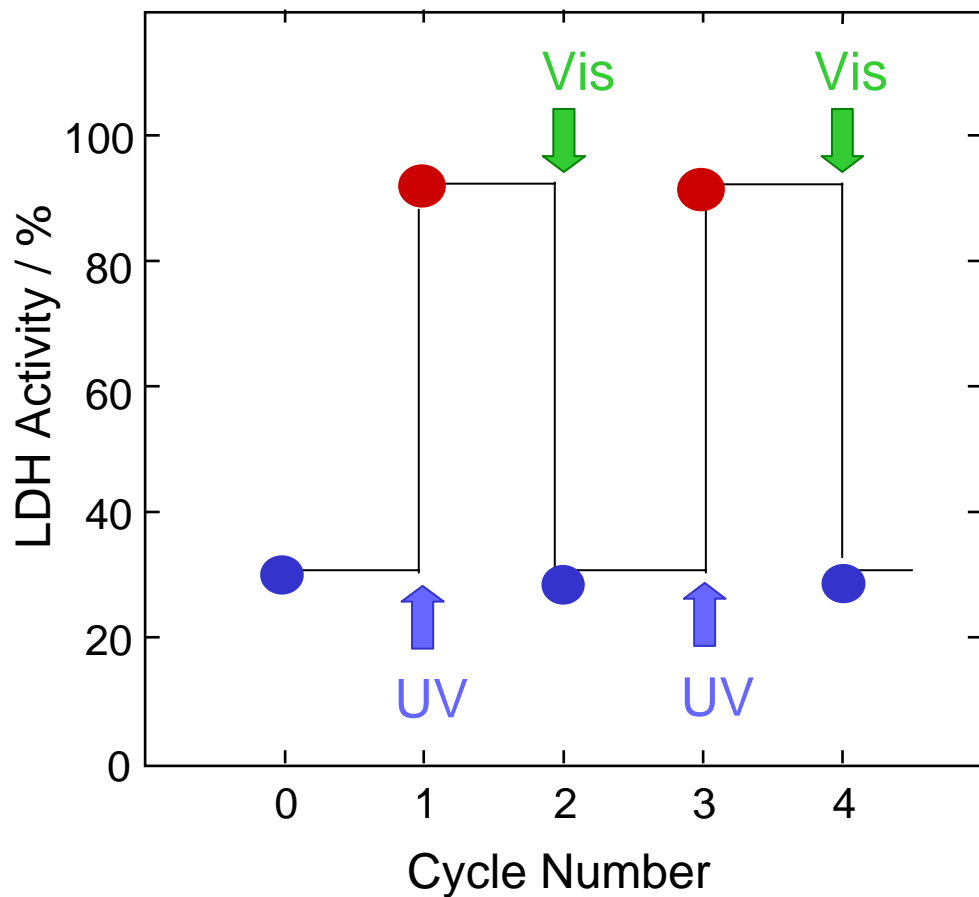


[AzoBis(His<sub>2</sub>C<sub>16</sub>)], 0.05 mM; [DMPC], 0.5 mM; [Zn<sup>2+</sup>], 0.5 mM;  
[Rho-PE], 1.3 μM; [NBD-PE], 1.3 μM; at pH 9 and 30 °C.

# 分子受信機での信号増幅



# 化学シグナル増幅の光スイッチング



[AzoBis(His<sub>2</sub>C<sub>16</sub>)], 50  $\mu$ M; [N<sup>+</sup>C<sub>5</sub>Ala<sub>2</sub>C<sub>16</sub>], 1.0 mM;  
[Cu<sup>2+</sup>], 4.0  $\mu$ M; [LDH], 2.8 nM; [NADH], 250  $\mu$ M;  
[Pyruvate], 500  $\mu$ M;  
in HEPES buffer (10 mM) at pH 7.0 and 40 °C.

