

10<sup>th</sup> U.S.-Korea Nano Forum, Boston, MA, Oct 15-16, 2013

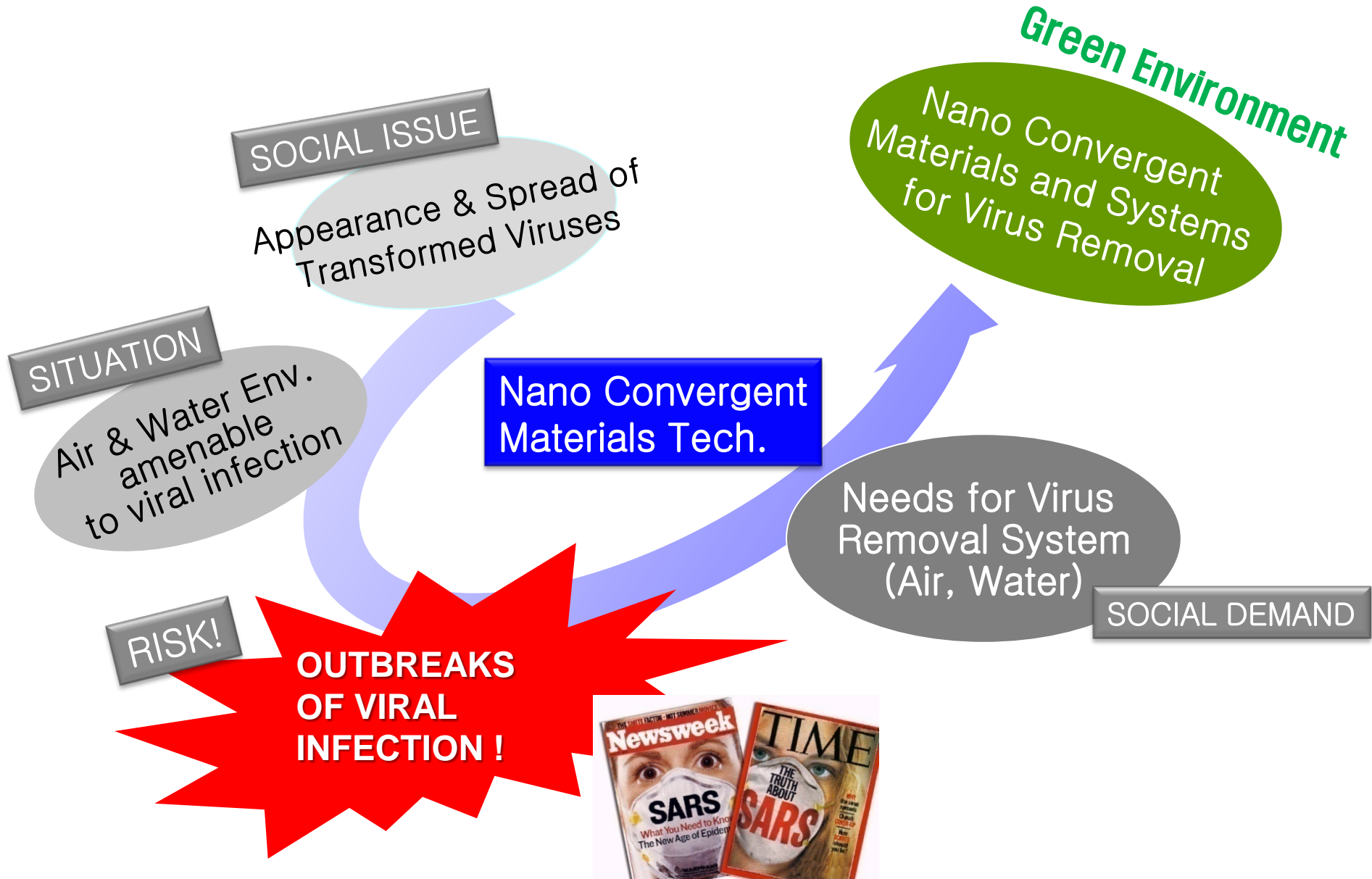
# **Synthesis & Antimicrobial Efficacy of Magnetic Silica Microspheres Decorated with AgNPs**

**Kyoungja Woo**

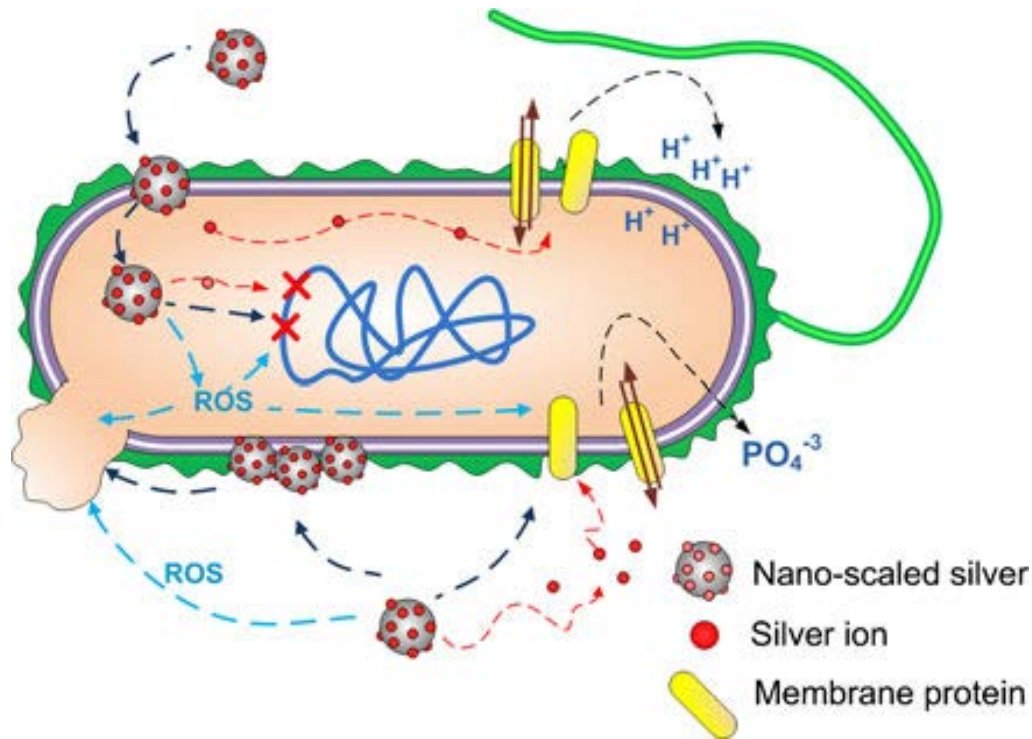
Korea **Institute** of Science  
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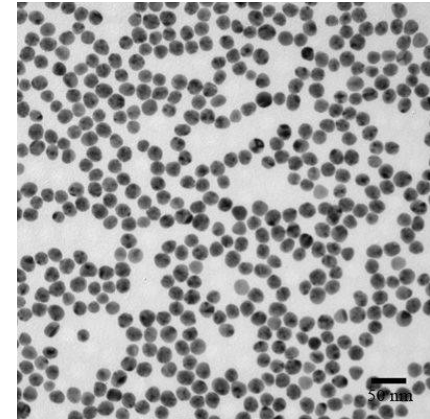
# Motivation of the Project



# AgNP interaction with bacterial cells



AgNPs

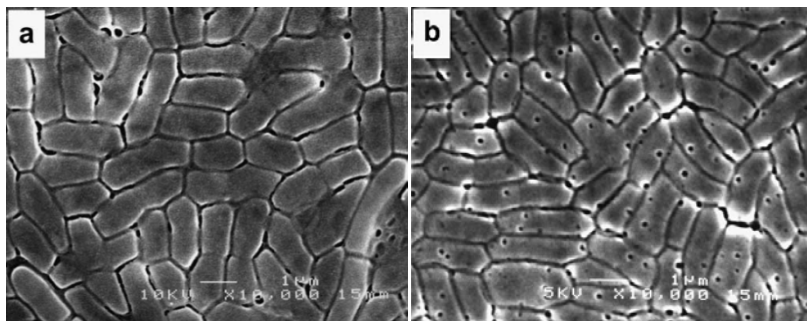
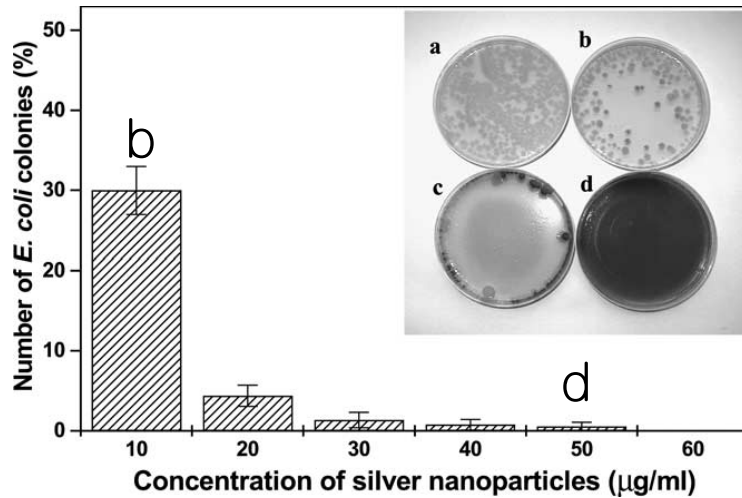


The smaller, the better

- 1) Release Ag<sup>+</sup> and generate ROS
- 2) Interact with membrane protein
- 3) Accumulate in the cell membrane
- 4) Enter into the cell

# AgNP interaction with microbial membranes

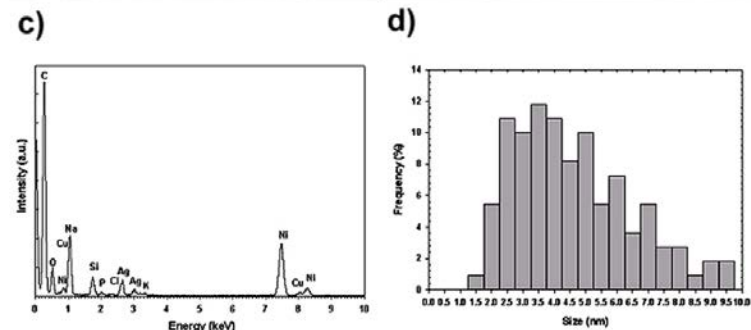
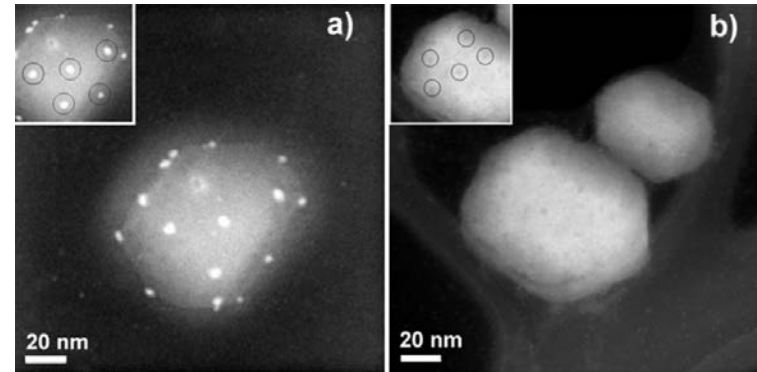
## AgNP (~12 nm) & *E. Coli*



Degradation of the membrane Structure

*Journal of Colloid and Interface Science*  
2004, 275, 177

## AgNP (<10 nm) & HIV-1



The AgNPs bind to the gp120 knobs (cysteine location) of HIV virus

*Journal of Nanobiotechnology* 2005, 3:6

# **Major challenges in practical utilization of AgNPs**

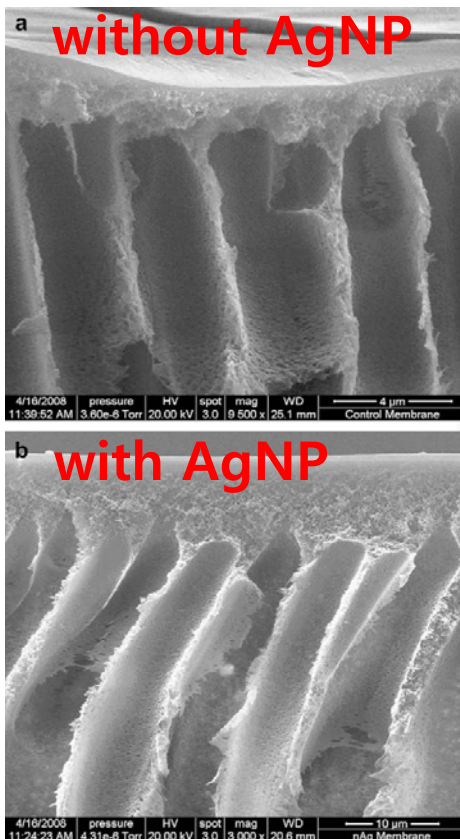
- 1. Aggregation of AgNPs**
- 2. Environmental release of AgNPs**

**\* The smaller, the better?**

# Organic Polymer–AgNP Composite

## Polysulfone ultrafiltration membrane impregnated with AgNP

(Membrane fabrication: 15% PSf, 10% PVP, 75% NMP, 0.9% AgNP)



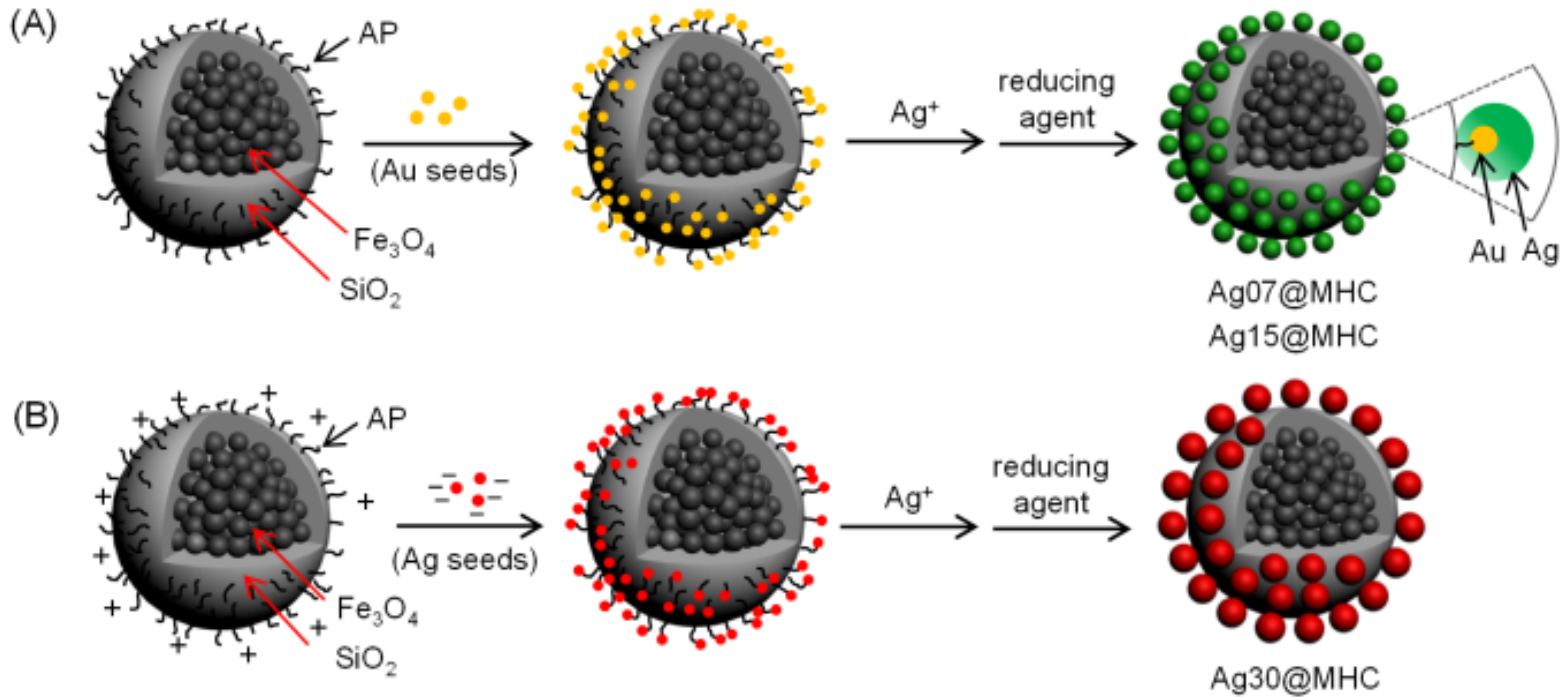
**Table 3 – Viral removal by membrane filtration. Plaque counts were performed on the influent and filtrates through PSf and nAg–PSf membranes. The values are expressed as average and standard deviation ( $n = 4$ ).**

Influent (PFU/mL)	PSf filtrate (PFU/mL)	nAg–PSf filtrate (PFU/mL)
$5 \pm 0.2 \times 10^5$	$625 \pm 35$	0
$6 \pm 0.1 \times 10^4$	$375 \pm 148$	0

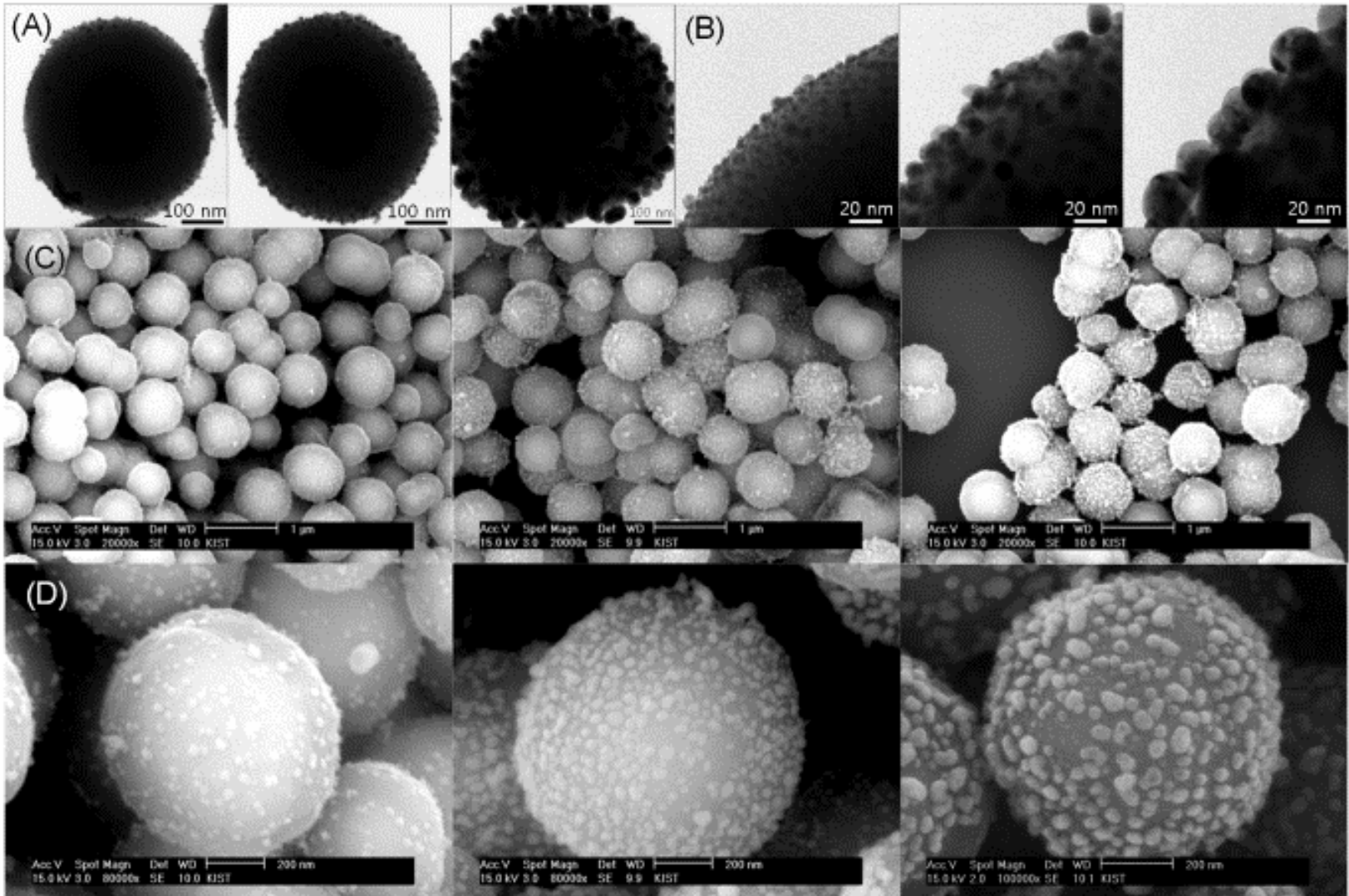
After filtration of 0.4 L/cm<sup>2</sup>, **10% AgNP loss !**

# Inorganic Superparamagnetic AgNP Composite

- Magnetic hybrid colloid decorated with AgNP (**AgNP@MHC**)



# Inorganic Superparamagnetic AgNP@MHC



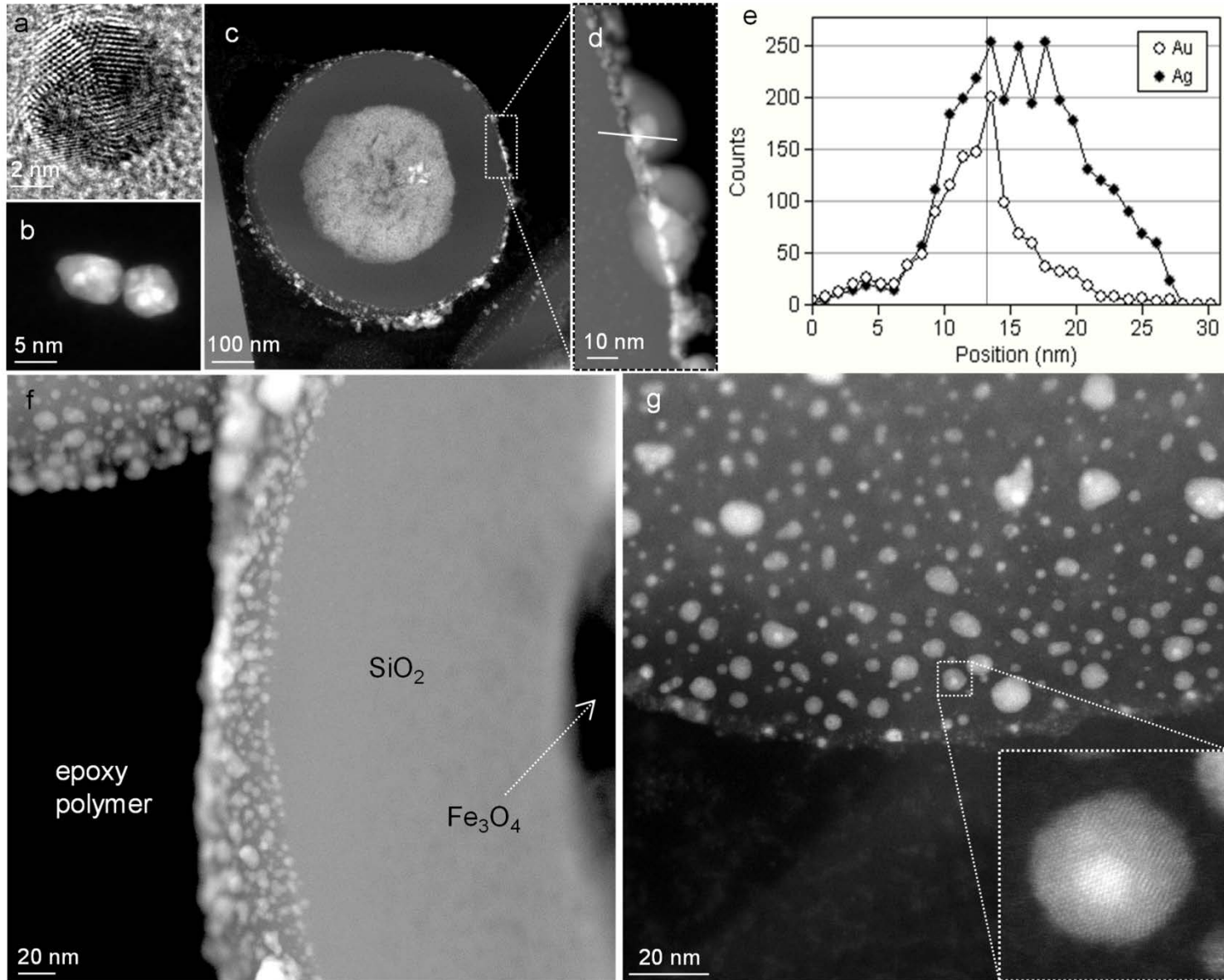
S. Coverage: 8.8%

25%

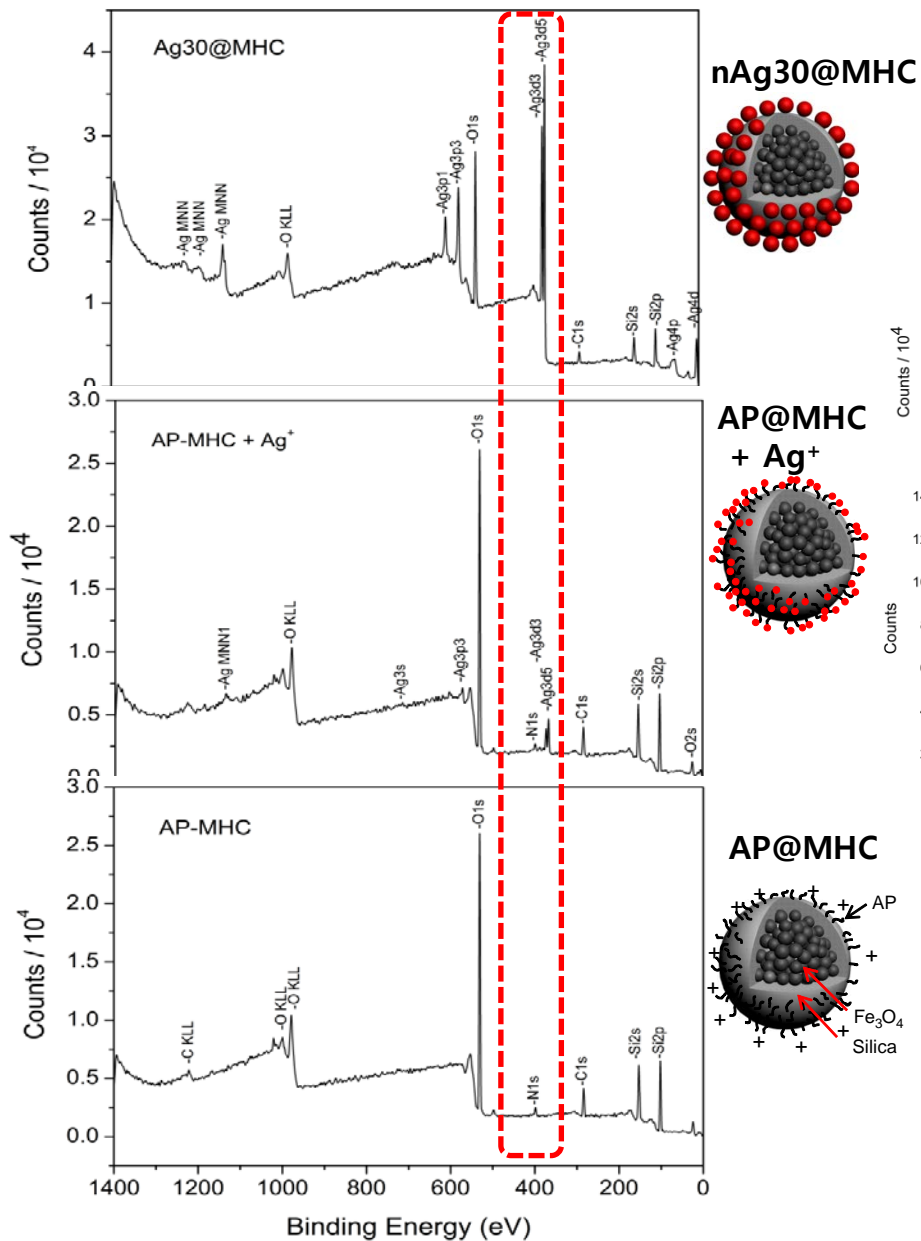
18%



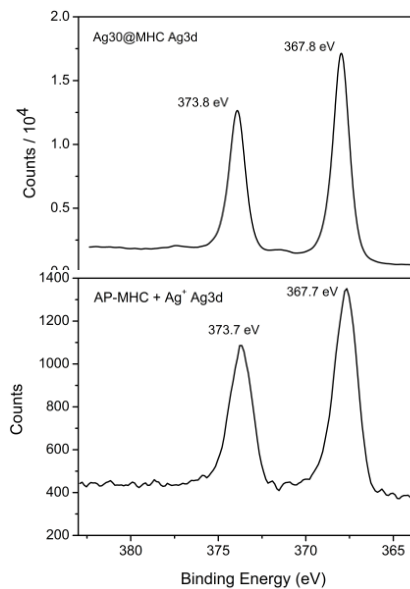
# Inorganic Superparamagnetic Ag/Au@MHC



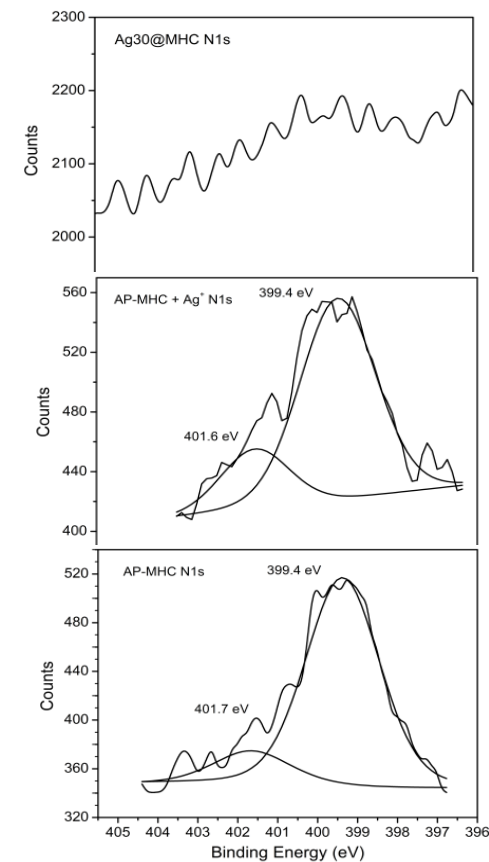
# XPS analysis of Ag/Ag@MHC



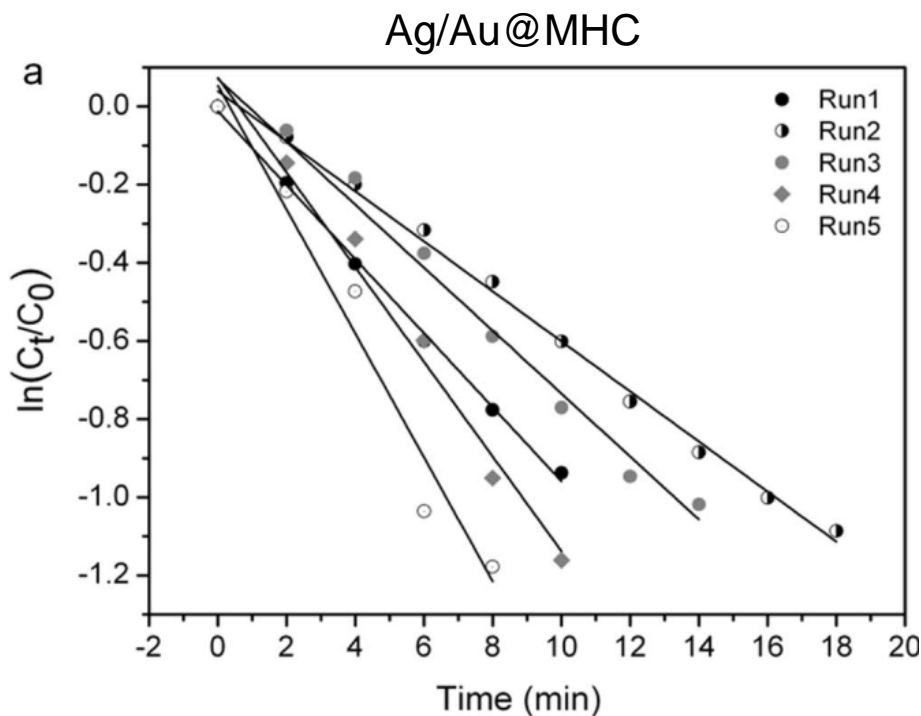
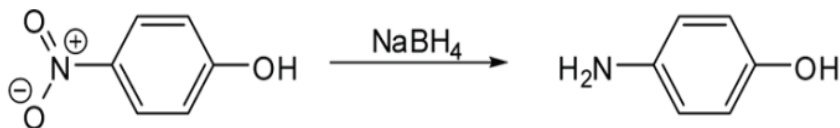
## Ag 3d<sub>5/2</sub>, 3d<sub>3/2</sub>



## N 1s



- Repeatedly usable noble metal nanocatalyst composite

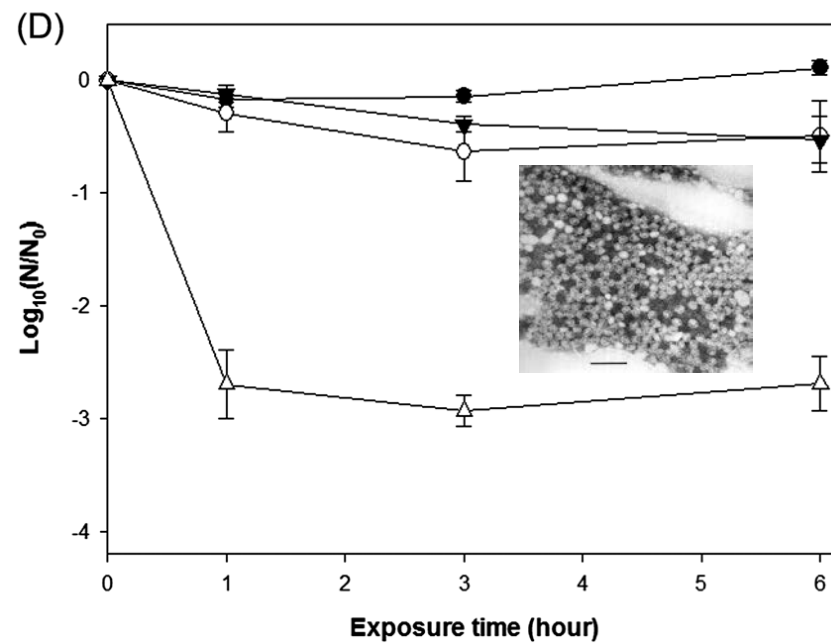
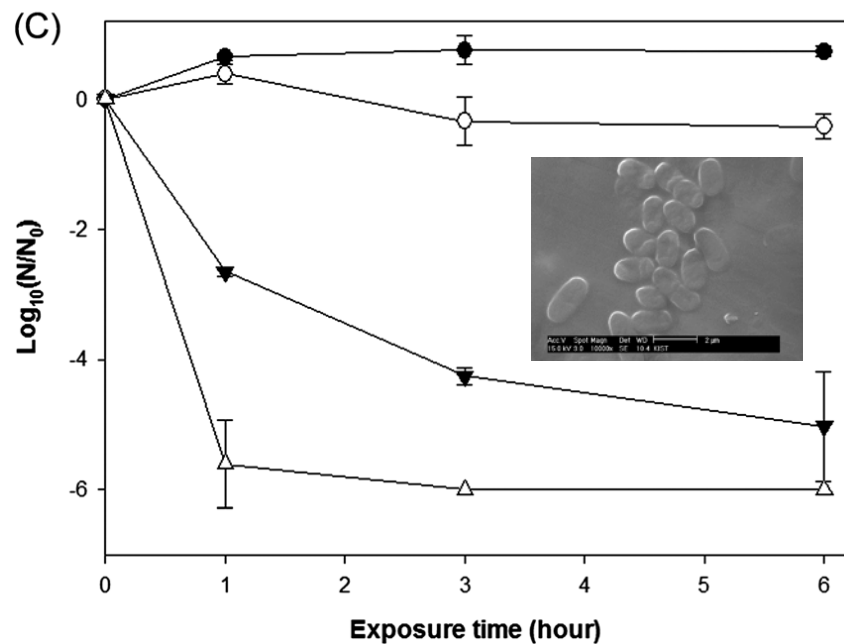
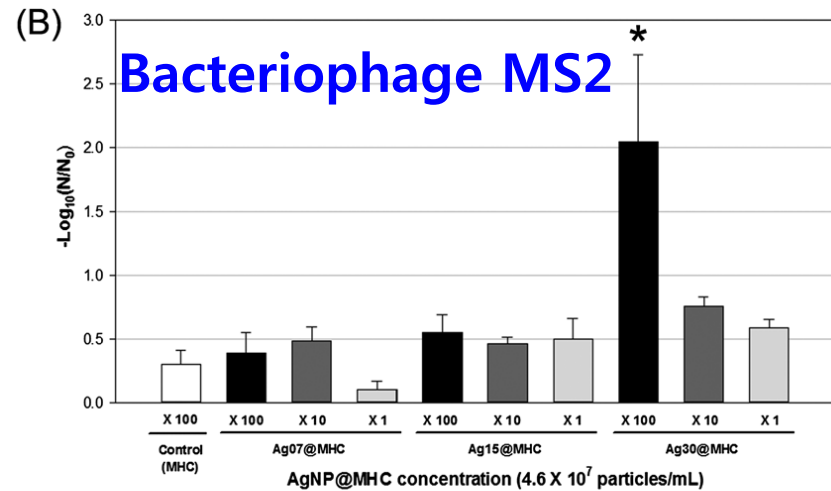
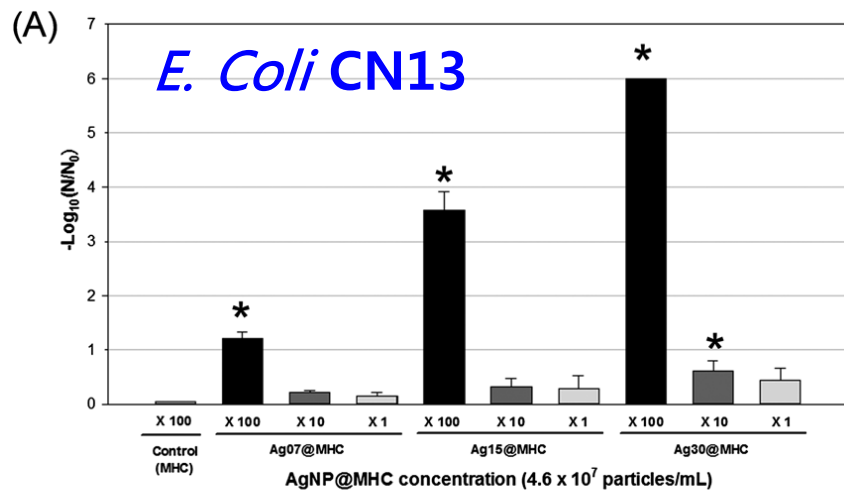


$$k_a = 0.095/\text{min}$$

$$\text{TOF}(\text{nAg/Au@MHC}) = 3.8 \times 10^{-3}/\text{s}$$

$$\text{TOF}(\text{chitosan-AgNP}_{5\text{nm}}) = 0.97 \times 10^{-3}/\text{s}$$

# Antimicrobial effects of AgNP@MHC



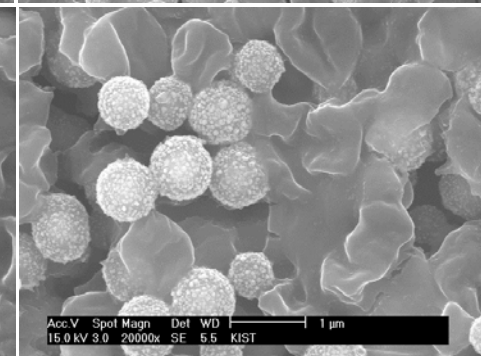
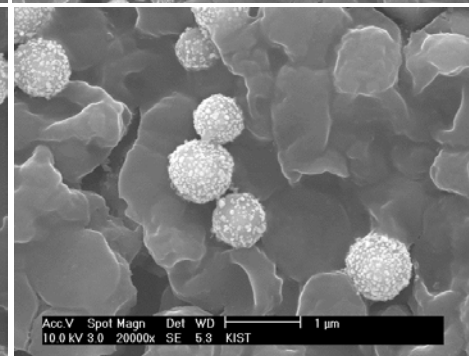
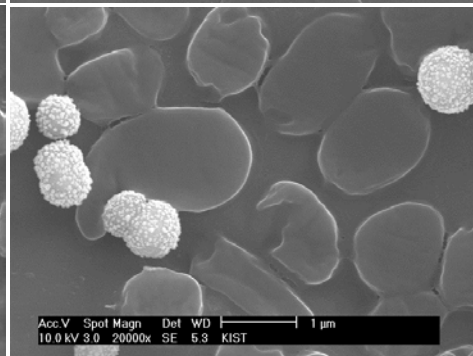
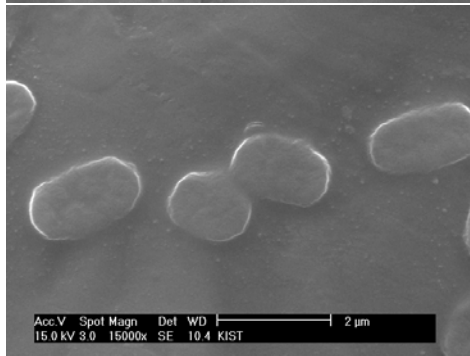
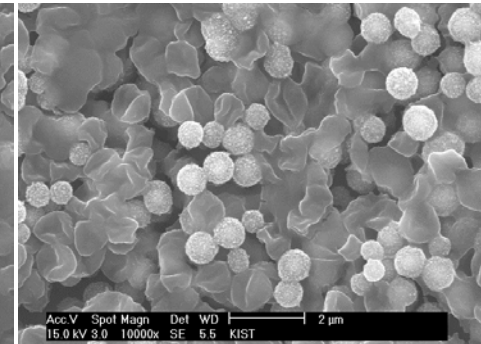
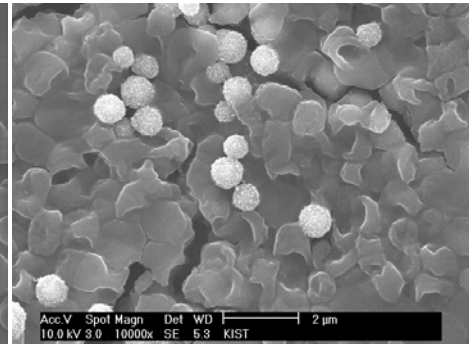
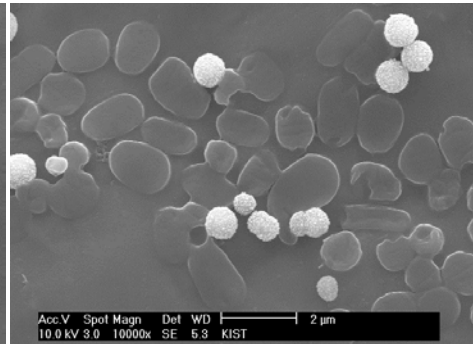
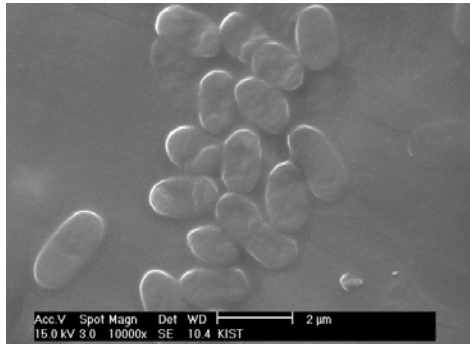
# AgNP@MHC bites away bacteria

*E.coli* CN13

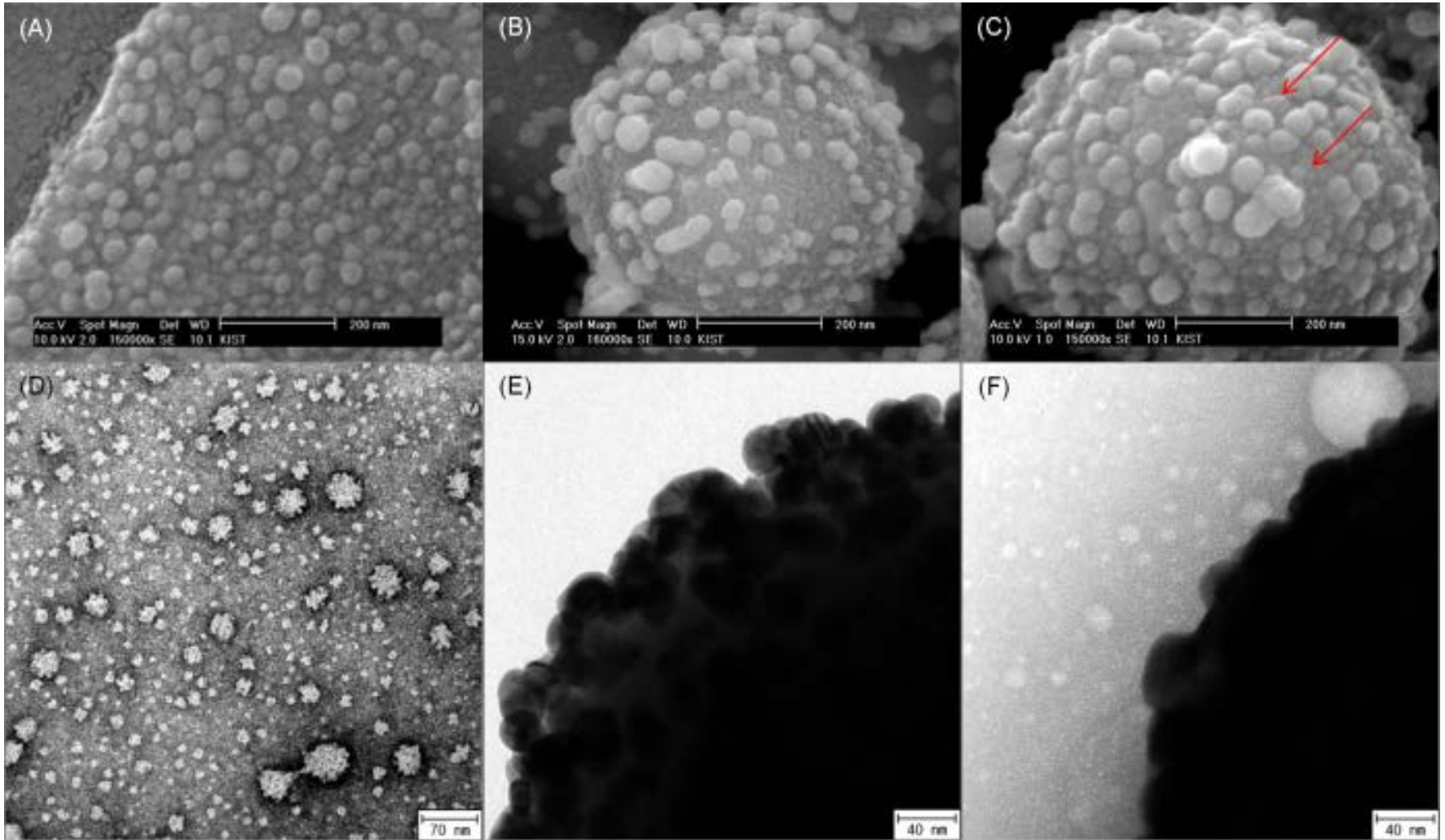
*E.coli* CN13+Ag30@MHC  
as-prepared

*E.coli* CN13+Ag30@MHC  
@30 min

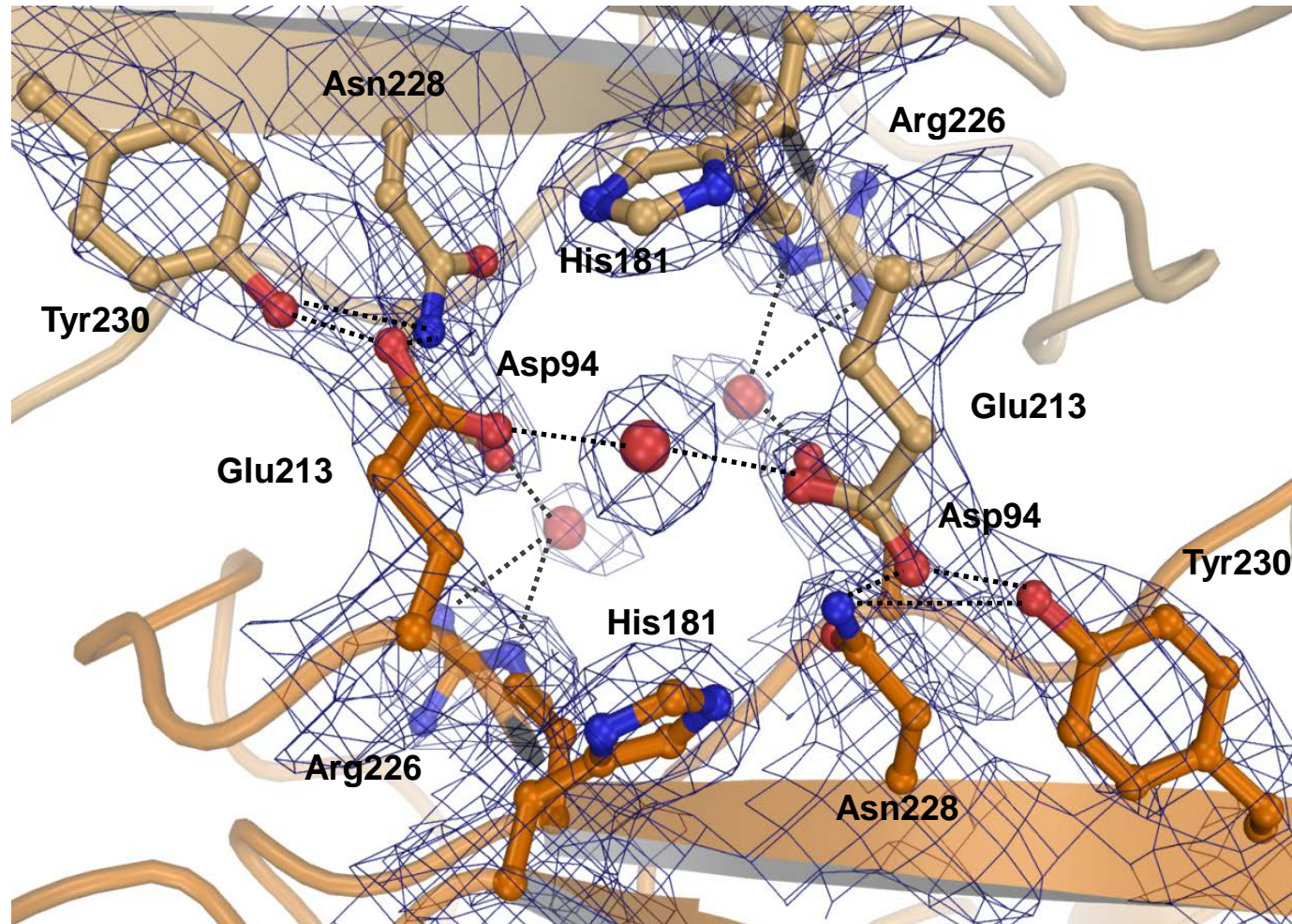
*E.coli* CN13+Ag30@MHC  
@60 min



# AgNP@MHC chemisorbs viruses (Bacteriophage MS2)

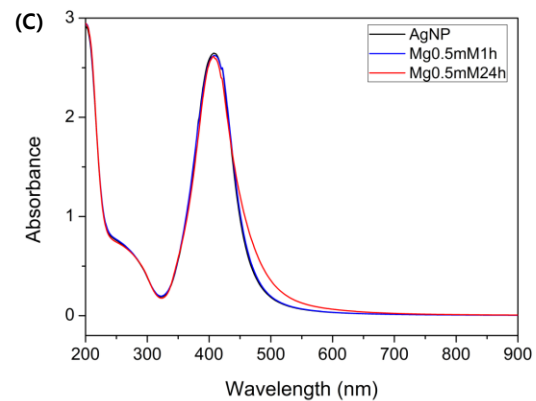
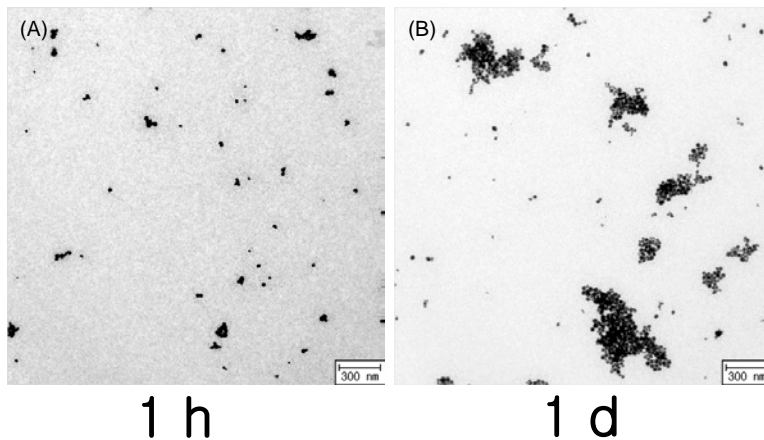
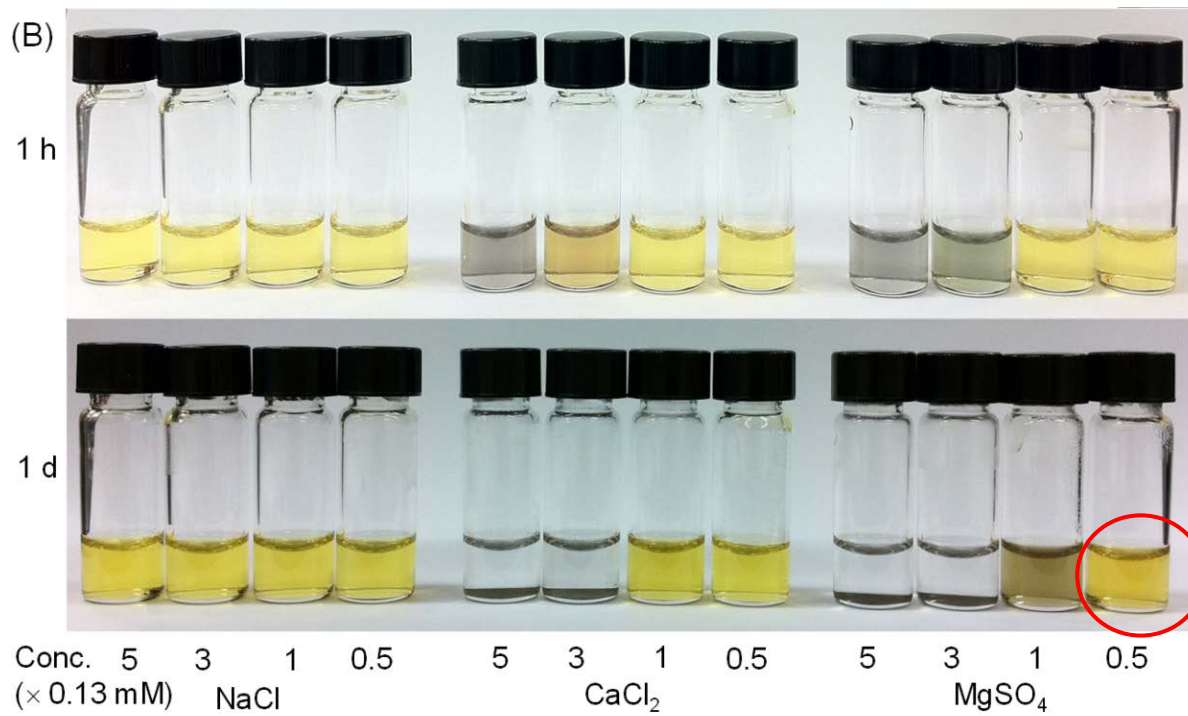


# Influenza viral HA structure (interactions at the dimer interface)



from Prof. Kyunghyun Kim in Korea University

# Mechanistic study for antimicrobial effects of AgNP (30 nm)



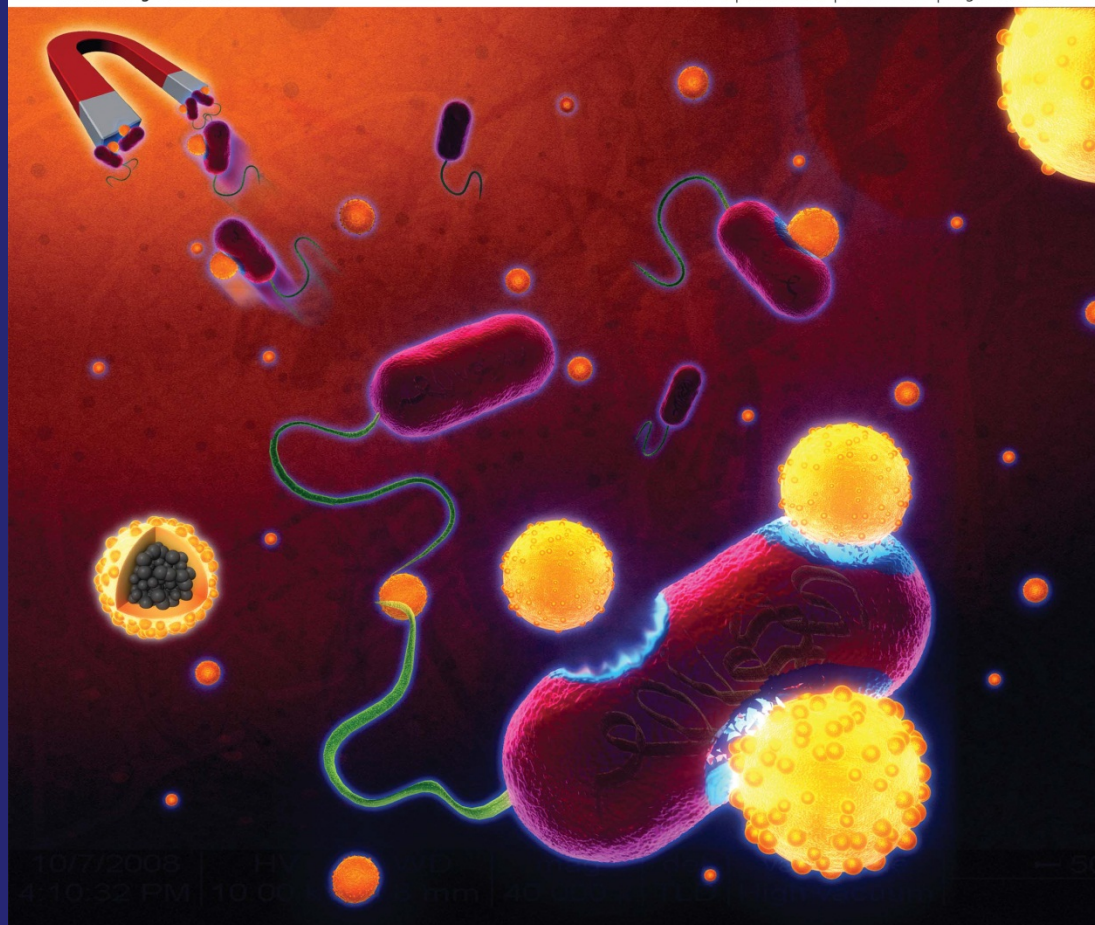


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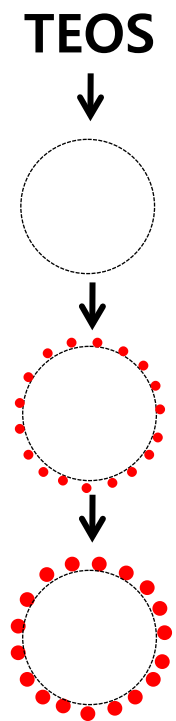
**PAPER**

Kyoungja Woo *et al.*  
Magnetic hybrid colloids decorated with Ag nanoparticles bite away bacteria  
and chemisorb viruses



2050-750X(2013)1:21;1-Y

# Scale-up synthesis for practical application



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**Thank you !**