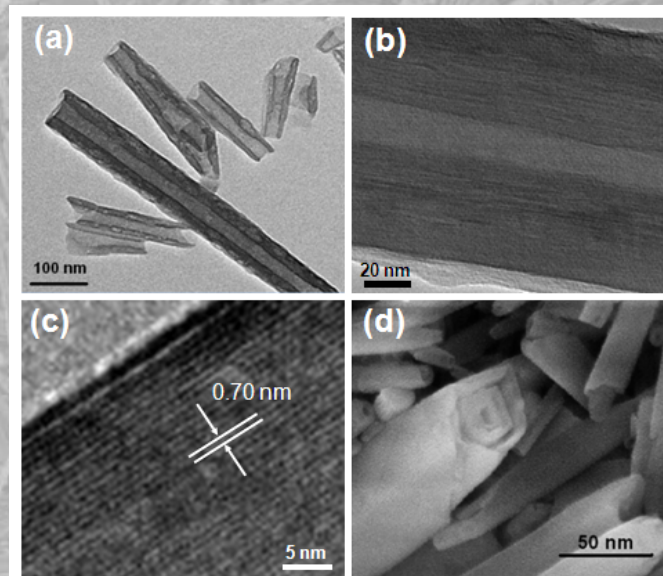


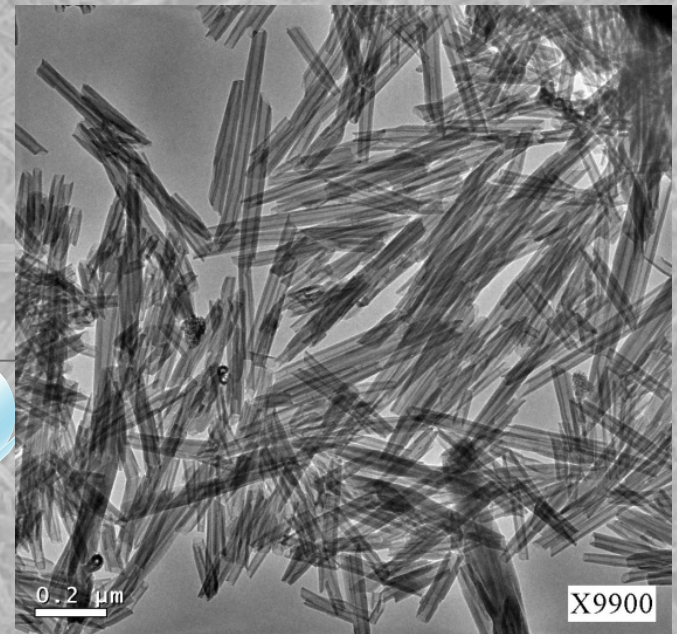
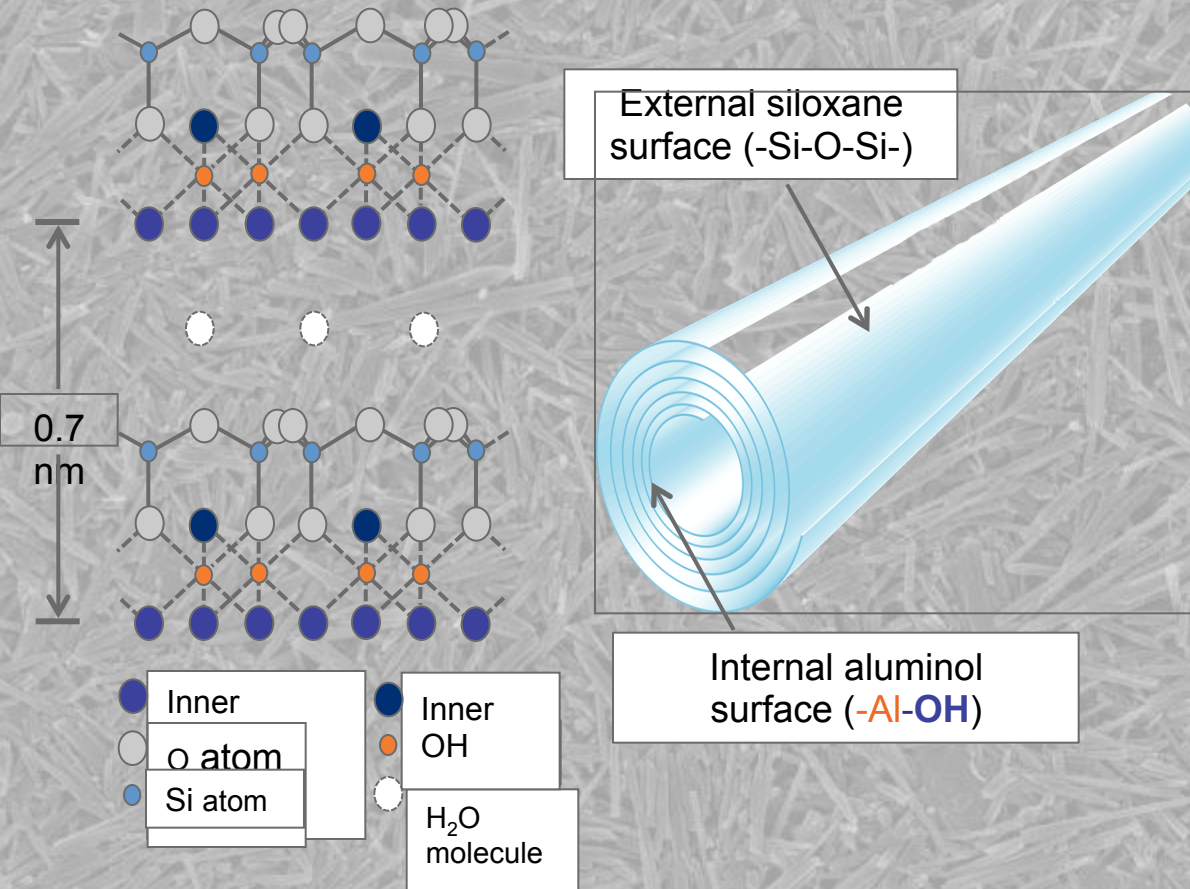
Timed Release of Medicine Using Halloysite Clay Nanotubes

Dr. Yuri M. Lvov & Yafei Zhao

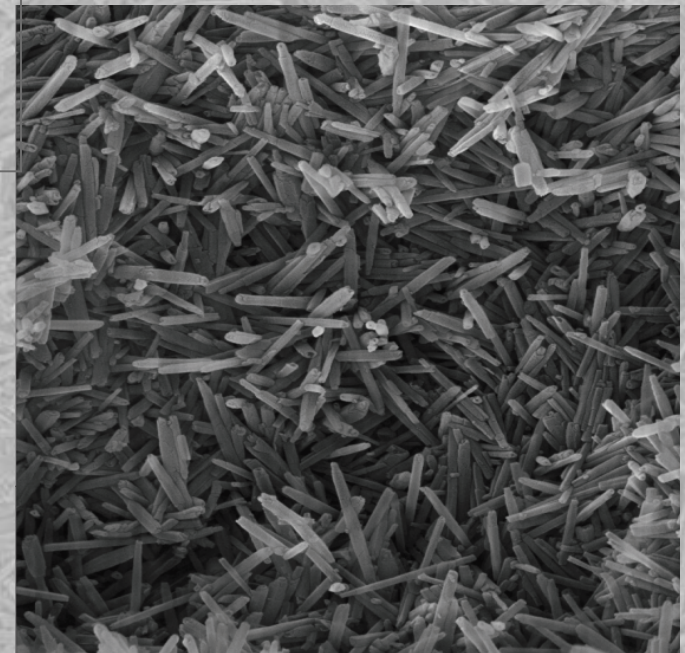
Theresa Do, RET Holly Ridge



Halloysite nanotubes



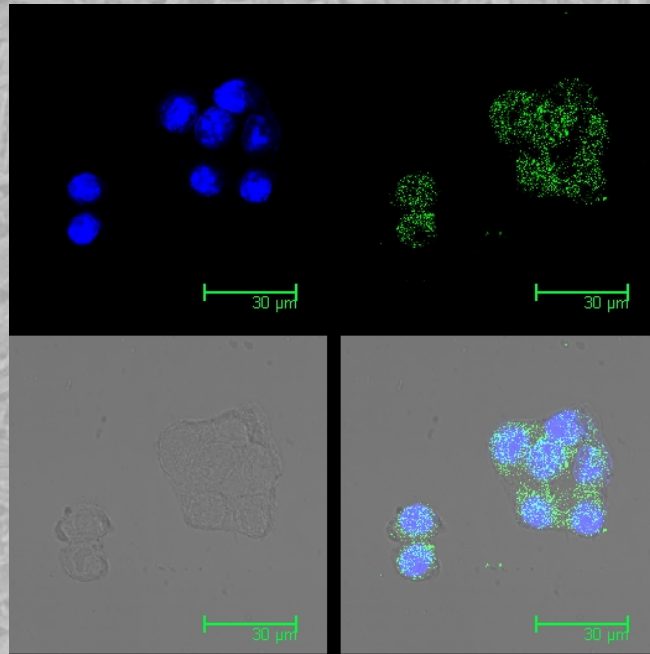
TEM, SEM halloysite images



50 nm outer and 15 nm inner diameters

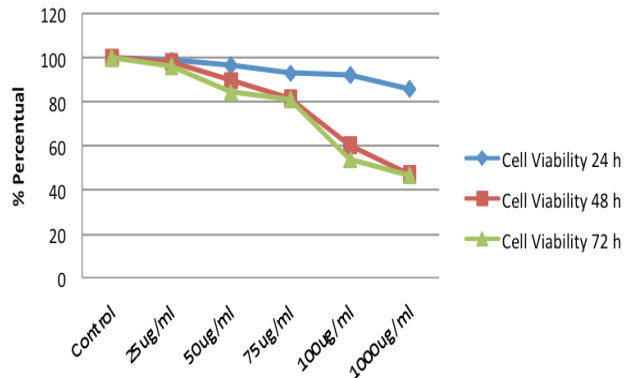
Halloysite - Biocompatible “Green” Nanoparticles

(in collaboration with S. Leporatti, NNL, Lecce, Italy)



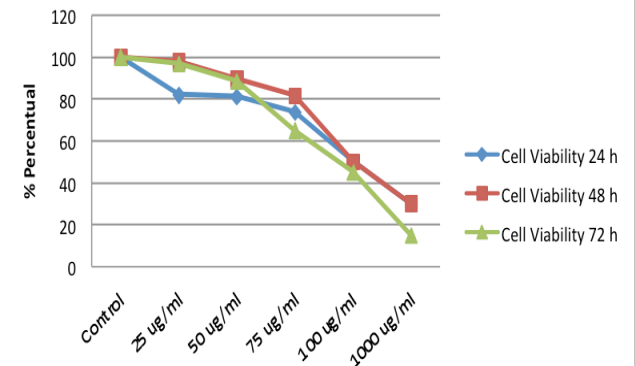
Made halloysite tubes fluoresce with aminopropyl triethoxysilane-FITC

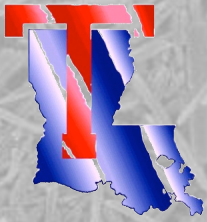
MCF-7



Trypan Blue test of HNTs in HeLa (and MCF-7 tissue cells). % Cell Viability vs HNTs concentration for 24-48-72 hours. It is much less toxic than usual table salt - NaCl (which kills cells at concentration of 5 μg/ml)

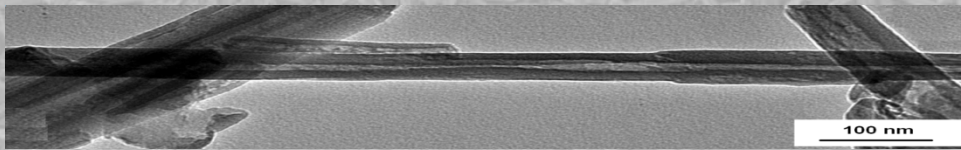
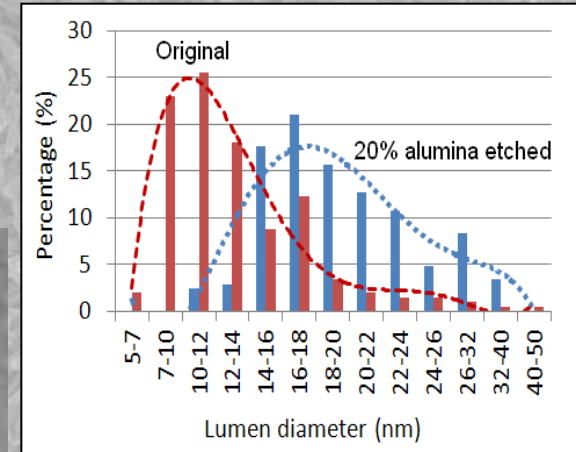
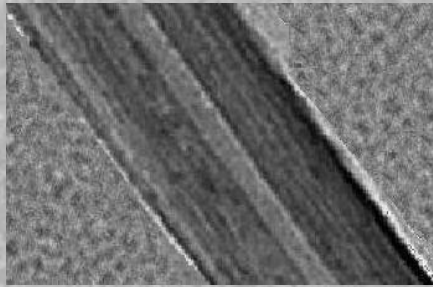
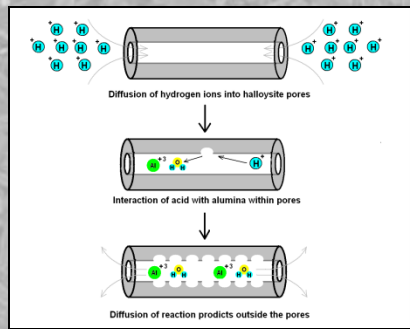
HeLa



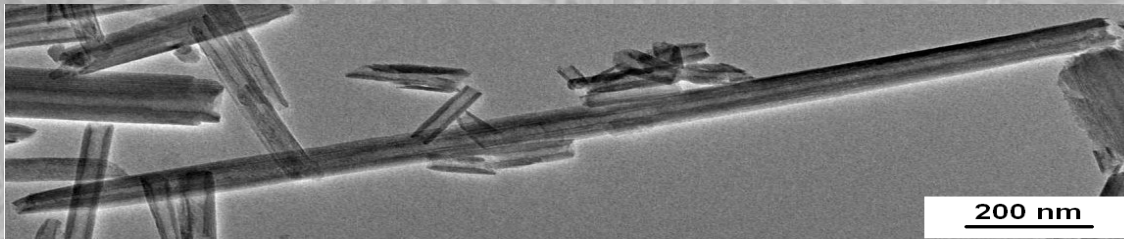
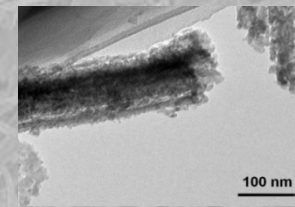


Selective etching of inner alumina allows for the tube loading capacity increase from 15 to 40%

Halloysites were stirred 8 hours in 1 M sulfuric acid solution at 80 °C.

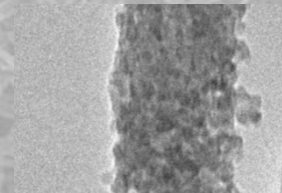


80° C



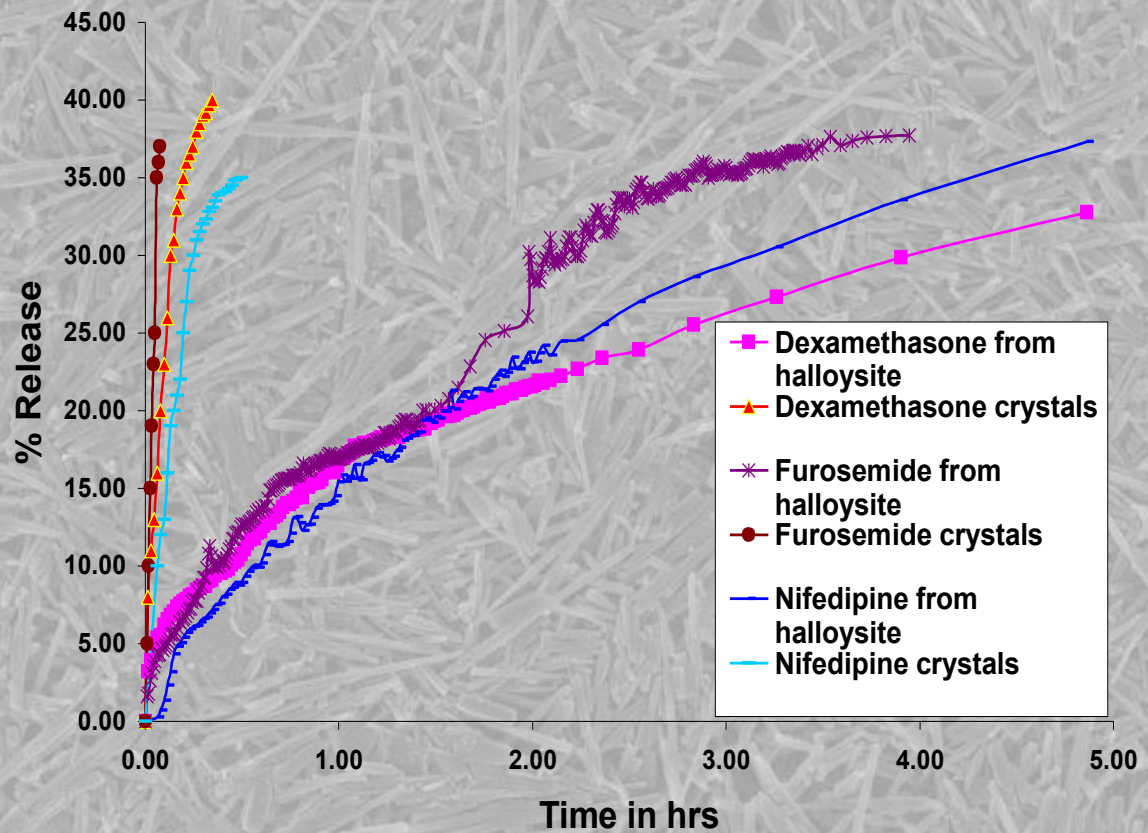
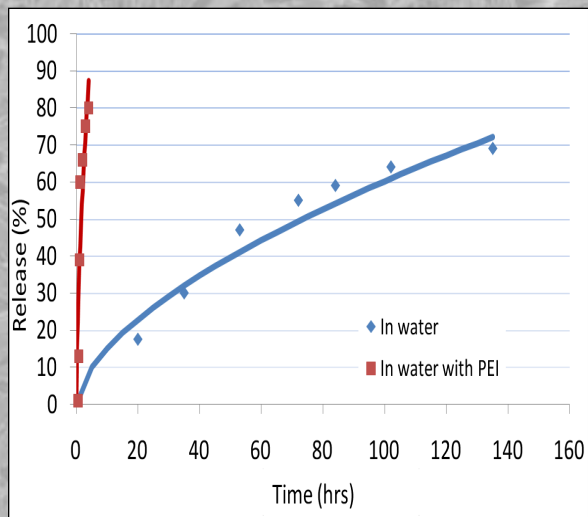
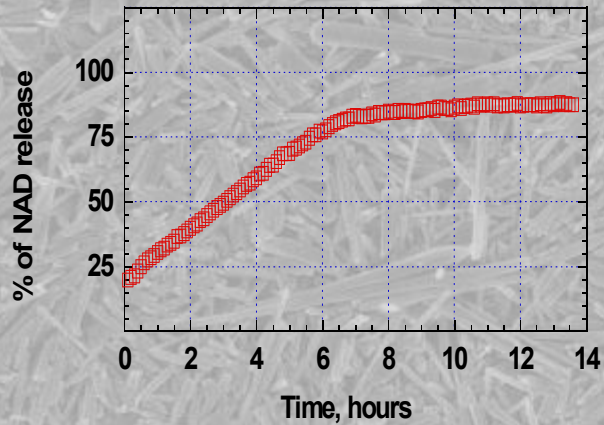
50° C

Longer treatment gives porous tube surface and surf area of 300 m²/g

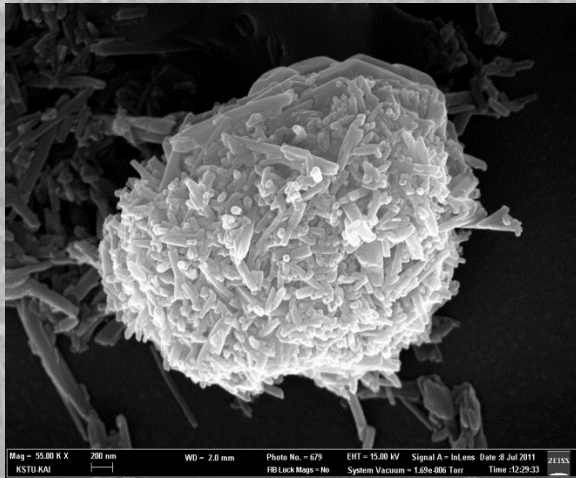


Sustained drug release

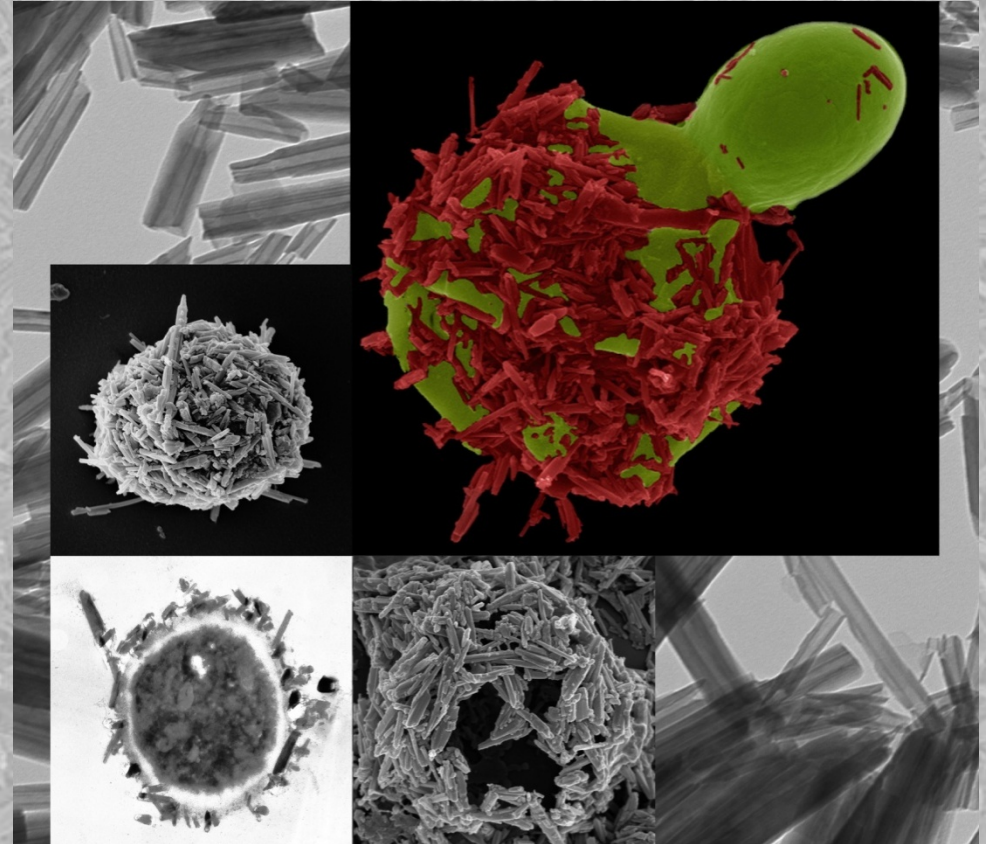
NAD, dexamethasone, furosemide, nifedipine release from halloysite (15 wt % loading, 10-20 hours complete release)



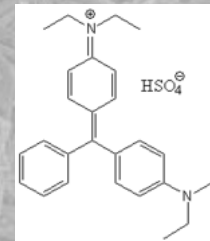
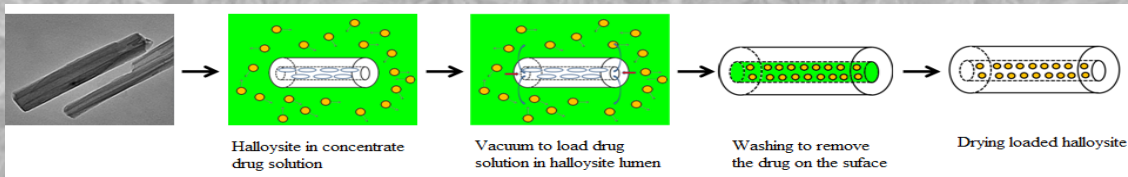
Biocell LbL encapsulation with polyelectrolyte and halloysite clay nanotubes



Algae cell coated with halloysite

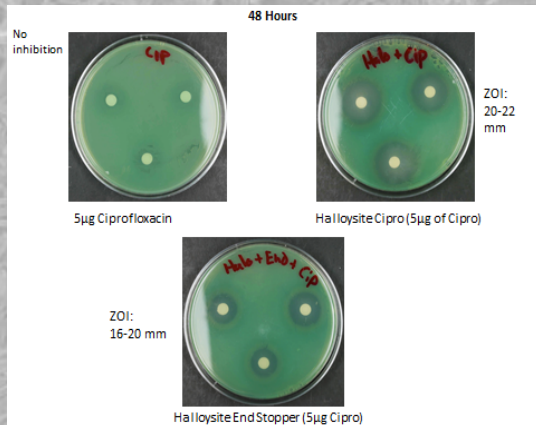
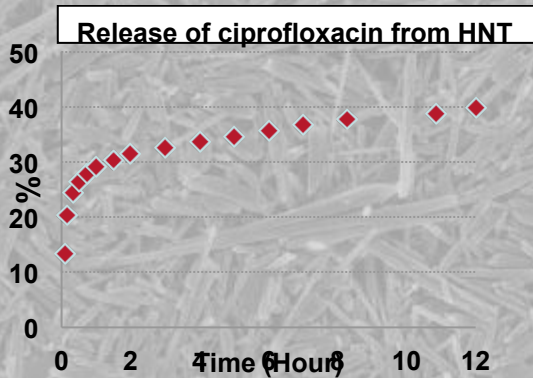


Green: Daughter cell without tube-skin and

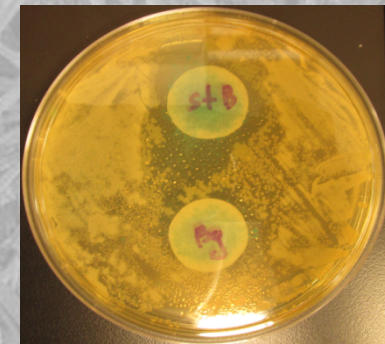
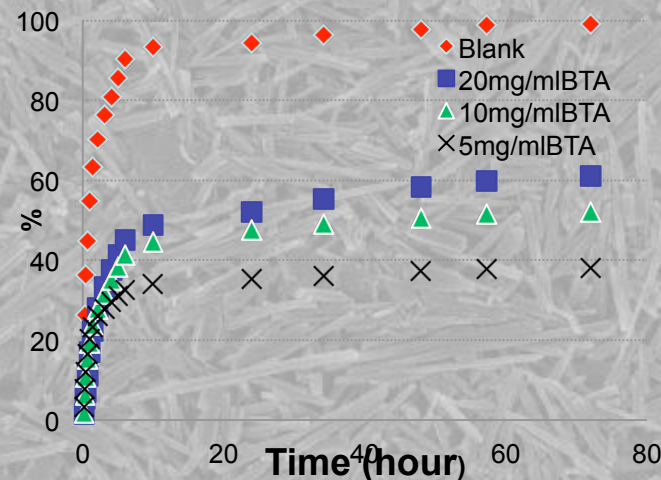
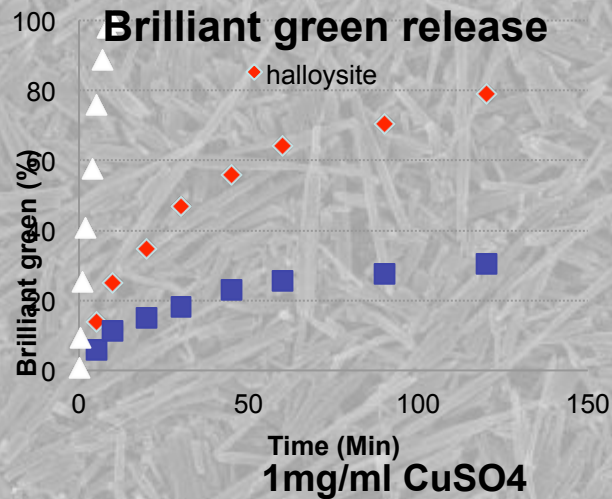


Antiseptic: Brilliant Green sustained release

Loading brilliant green in halloysite rinsed sequentially with benzotriazole and copper sulfate to form stoppers on the leaking pores.



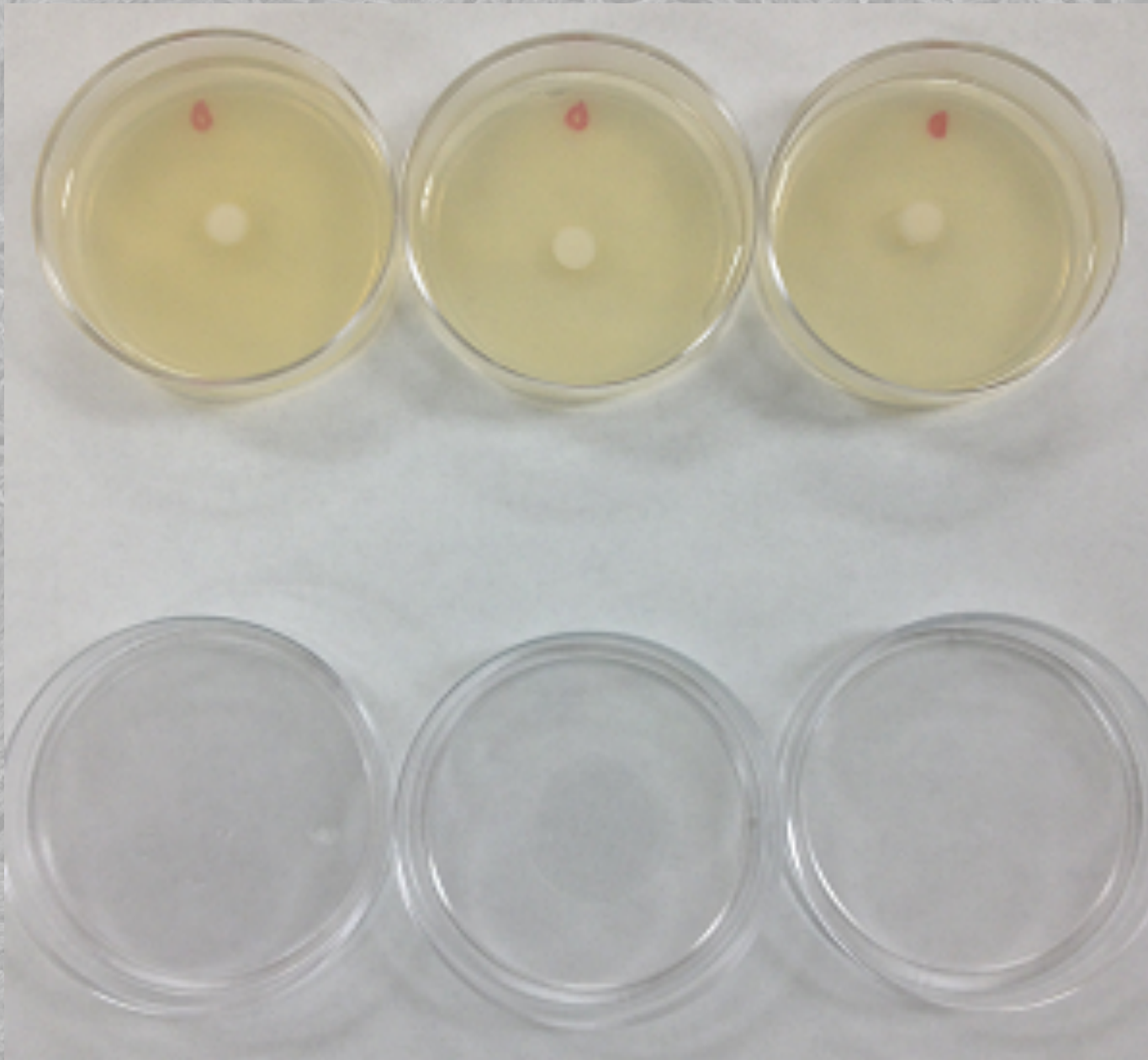
Antibiotic ciprofloxacin sustained release from 8 % halloysite and *P. aeruginosa* 48 h-inhibition with ciprofloxacin-halloysite (MDR-gangrene)



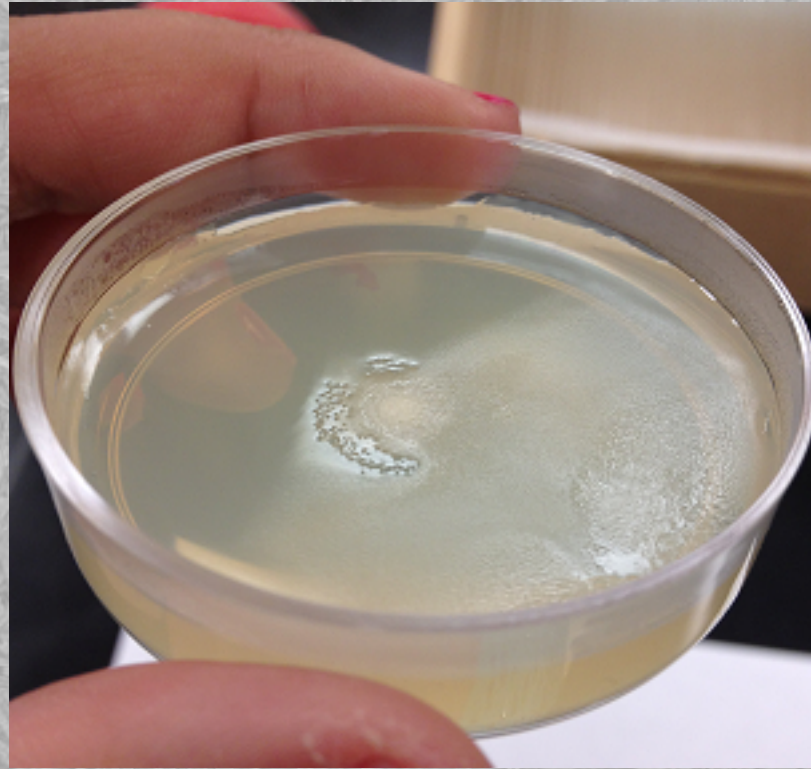
Staphylococcus aureus was grown in TSB, incubated for and 48 h at 37°C. Bg:50mg brilliant green loaded halloysite, stB:50 brilliant green loaded halloysite with stoppers

Research Procedure

1. Set up nutrient agar in Petri dishes (24 hrs)
2. Using the Kirby Bauer method, inoculate dishes with bacteria (*E. coli* – 24 hrs) & treatments
 - a) Control (water)
 - b) Nanotubes
 - c) Eukalyptol
 - d) Eukalyptol & nanotubes
 - e) Dakin's solution
 - f) Dakin's solution & nanotubes
 - g) Iodine in alcohol
 - h) Iodine in alcohol & nanotubes
3. Analyze and record results – Zone of Inhibition



Results



Eukalyptol & Nanotubes

Cologne & Nanotubes

(Old Spice off brand)

Date	Time	Tester 1		Tester 2		Tester 3	
7/9/14	4:15 pm	+	-	-	+	+	-
7/9/14	7:45 pm	-	+	-	+	-	+
7/10/14	3:32 pm	-	+	-	+	-	+



Acknowledgements

- **Dr. Yuri Lvov & Yafei Zhao**
- **Kris Kelley & Soil Analysis Lab**
- **LaSIGMA**
- **IfM @ LaTech**



Lab Activity – Potpourri bags

- 1. Choose bag**
- 2. Add one pinch of nanotubes into bag**
- 3. Add **only 2** drops of scent into bag**
- 4. Tie off bag and allow to dry**