Nanomaterials in Disinfection Applications and Self Disinfecting Surfaces

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Thanks to

biosav
Çabamız İnsan İçin...

Eczacıbaşı

MİKROPEST
İLAÇ KİMYA

cmf
Cem-fa ilaçlama ltd. şti.

ÇEVRE İLAÇ MAKİNA

BAYER

Goizper Group
Growing through cooperation

LİVFARMA
Hayatın içinden...

Envira

Chrysamed

roksan
İlaç San. ve Tic.Ltd.Şti.

MICRON GROUP
PRECISION APPLICATION

iK
BY EXPERTS
FOR EXPERTS

LABORATUVAR, GÖZETİM VE ARAŞTIRMA GELİŞTİRME MERKEZİ
EKOTEKS
LABORATUVAR VE GÖZETİM HİZMETLERİ AŞ.

syngenta

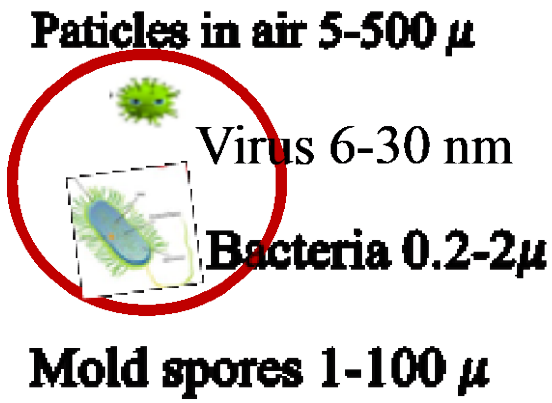
Sabancı Üniversitesi

How big is the cross contamination problem?

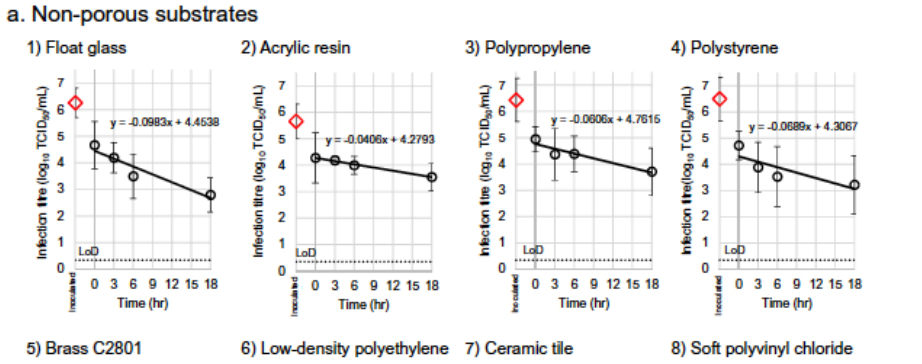
- Coronavirus-Pandemi
  - Globally, as of 4:36pm CET, 4 November 2022, there have been 630 million confirmed cases of COVID-19, including 6,576,088 deaths, reported to WHO.
- Hospital Associated Illness
  - The US Center for Disease Control and Prevention identifies that nearly 1.7 million hospitalized patients annually acquire HCAIs while being treated for other health issues and that more than 98,000 of these patients (one in 17) die due to HCAIs.
- Food borne illness
  - The World Health Organization (WHO) estimates that the consumption of contaminated food results in about 620 million cases of foodborne illness, which are responsible for 420.000 deaths every year (WHO, 2020).
- Indoor Air
  - 7 Million of people die from air pollution each year

What coronavirus taught us

- Cross contamination
  - Hospital associated infections
  - Epidemic
  - Pandemic
- Importance of
  - Hand cleaning
  - Use of masks
  - Disinfectant use and hygienic surfaces



Survival of SARS-CoV-2 and bovine coronavirus on common surfaces of living environments



Organism	Length of Survival on Surfaces
Staphylococcus aureus	7 days – >1 year
Clostridium difficile	5 months
Klebsiella spp.	<1 hour – 30 months
E. coli	<1 hour – 16 months
Acinetobacter spp.	3 days - 5 months
Adenovirus	7 days – 3 months
Norovirus	Norovirus (including Feline Calicvirus) 8 hours – 14 days
Pseudomonas aeruginosa	6 hours – 16 months
VRE	5 days – 4 months

Scientific Reports | (2022) doi.org/10.1038/s41598-022-14552-9

Conventional Disinfectants

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Volatile

- Halogens - Chlorine, hypochlorite (Clorox), chloramines, iodine, iodophors, Bleach hypochlorous acid (HOCl))
- Alcohols - Ethanol, Isopropanol
- Hydrogen Peroxide and per-acids
- Gases and Aerosols - Ethylene oxide, propylene oxide and chlorine dioxide.

Non Volatile easily washable

- Detergents and soaps - Quaternary ammonium compounds (QUATS)
- Phenol (Phenolics) - Lysol, Triclosan: soap antibacterial additive
- Chlorhexidine - halogen and phenol compound
- Aldehyde - glutaraldehyde and formaldehyde
- Organic Acids - Used in foods to inhibit microbial growth.

Metal Ions and Metal Oxide - Ag (Silver), Hg (mercury), Cu (copper), Zn (zinc) and derivatives.

Do we need Self-Disinfecting surfaces?

- Surface cleaning efficiency of the Thirty-six acute care hospitals in the United States ranging in size from 25 to 721 beds were studied.
- Of 20,646 standardized environmental surfaces (14 types of objects), only 9,910 (48%) were cleaned at baseline (95% confidence interval, 43.4–51.8).
- After implementation of interventions and provision of objective performance feedback to the environmental services staff, it was determined that 7,287 (77%) of 9,464 standardized environmental surfaces were cleaned
- The potential development of self-disinfecting surfaces has tremendous possibilities. Most importantly, the use of such surfaces could minimize the impact of poor cleaning and disinfecting practices during routine and terminal room cleaning and disinfection.

Infection Control and Hospital Epidemiology, November 2008, vol. 29, no. 11, p 1035-1041

Sabancı Üniversitesi

Why Permanent Antimicrobial Self Disinfecting Surfaces?

Introduction: Why Antimicrobial Self Disinfecting Surfaces?

- Conventional disinfectants or antimicrobial agents are solids, liquids, or gases of low molecular weight compounds - frequent applications needed.
- The problems of residual toxicity of the agents - environmental pollution
- Case in food packaging: Risk of diffusion of the agents into the food
- Case of water treatment: The residues of chlorine can become concentrated in the food chain and environment.

- Polymeric agents: Nonvolatile, chemically stable, and difficult to permeate through the skin of a man or animal
- May enhance the efficacy of existing antimicrobial agents
- Minimize the environmental problems
- Controllability

UN SDG GOALS

- Good Health and Well Being
- Descent Work and Economic Growth
- Zero Hunger
- Clean Water and Sanitation
- Responsible Consumption and Production
- Climate Action

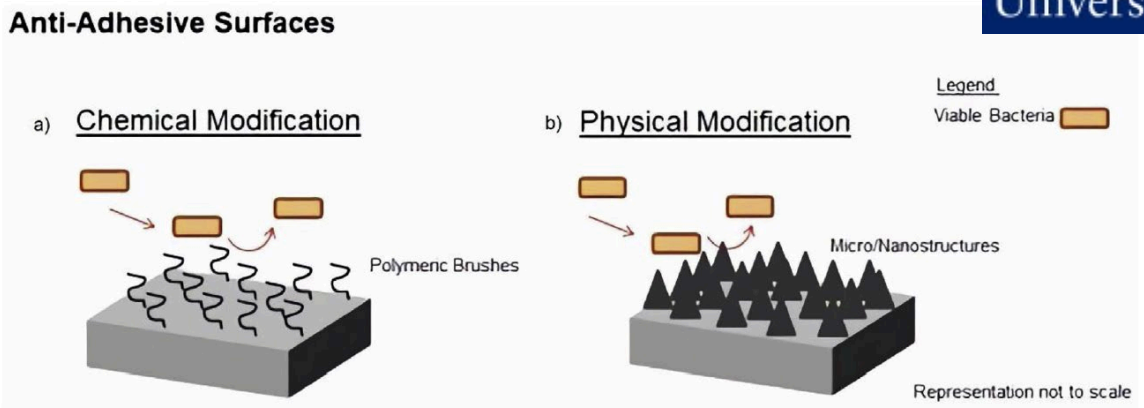
NANO EFFECT

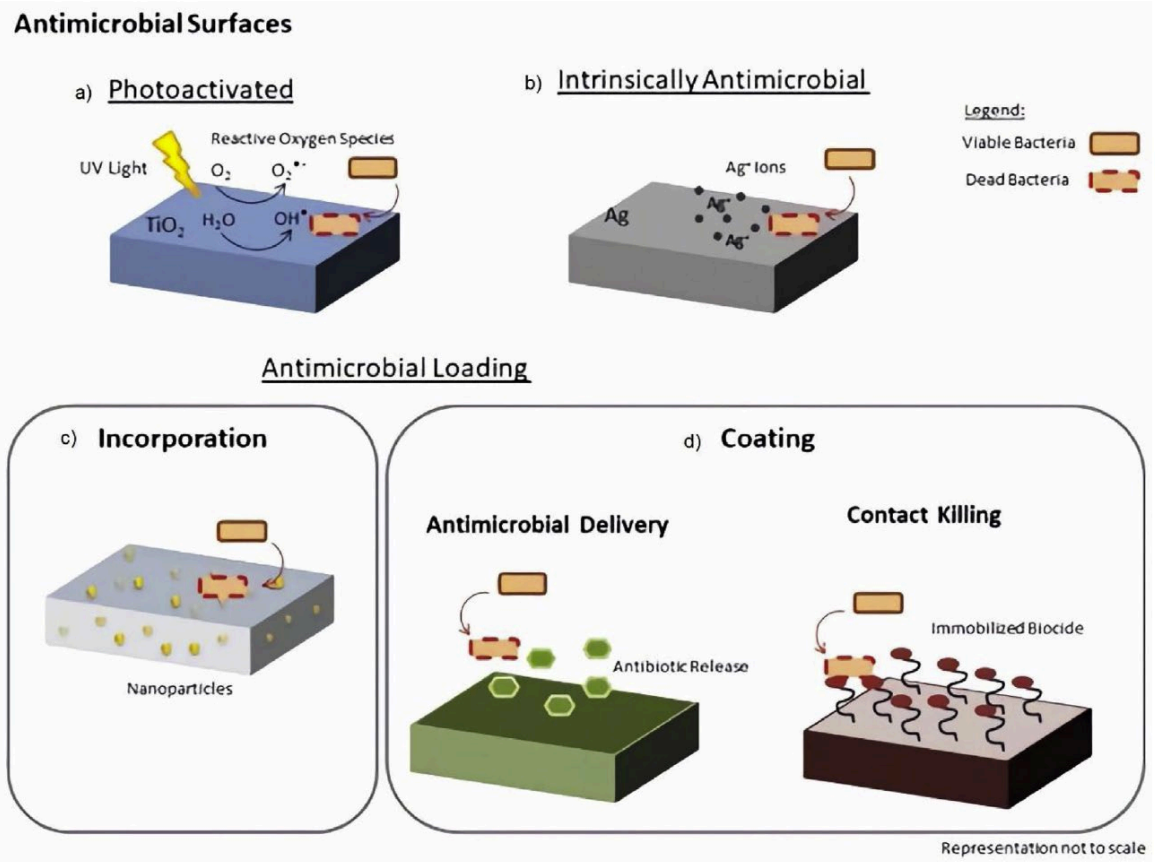
- Less Material
  - Nano size,
  - High surface area
  - Maximum interface
- More Effective Functions
  - Multi functional
- Cost Effective

International Association for Soaps, Detergents and maintenance Products priorities

Antimicrobial Surfaces

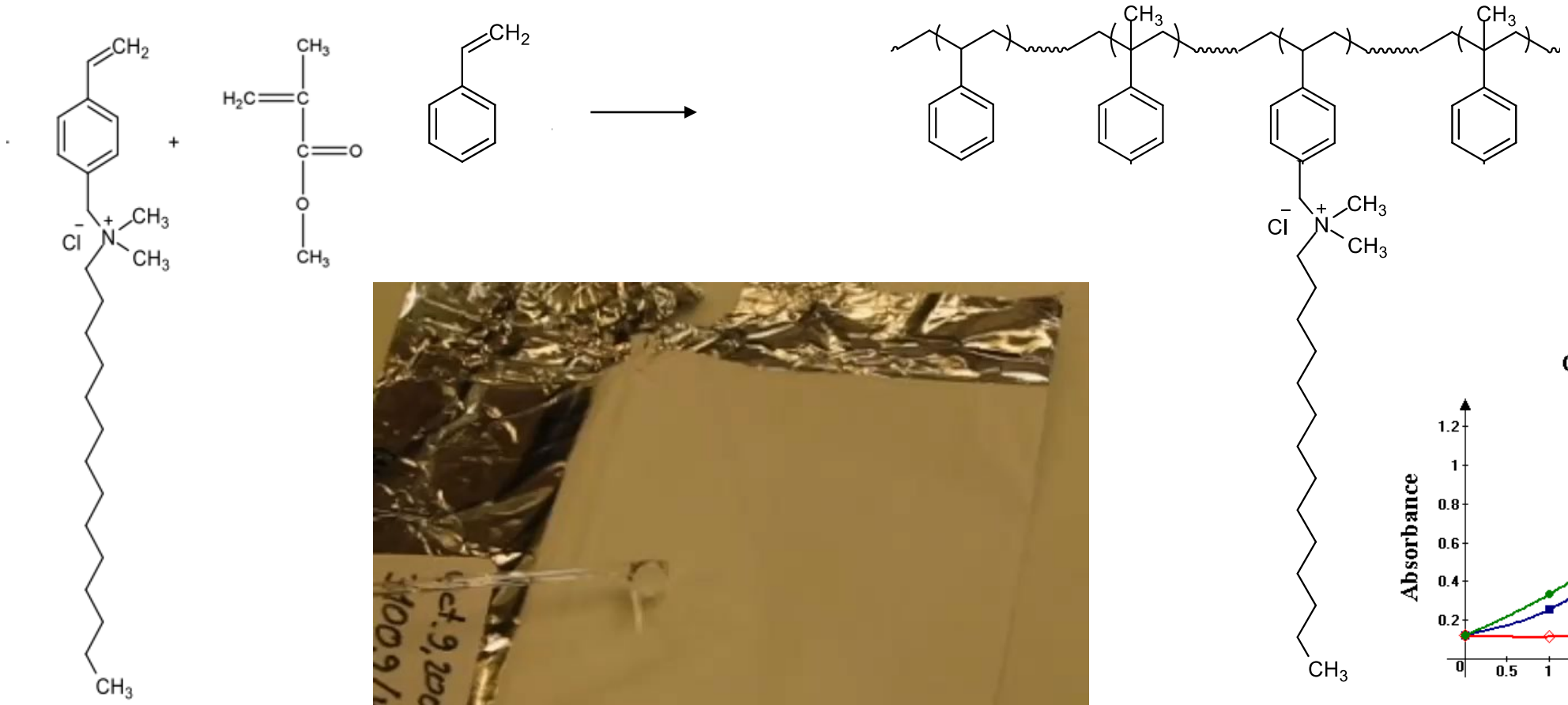
- Anti-adhesive surfaces
  - Chemical modification
  - Physical modification
- Antimicrobial surfaces
  - Intrinsically active antimicrobial materials
  - Loading antimicrobial compounds into materials
    - By incorporation
    - By coating
  - Photo-activated surfaces (TiO_2)

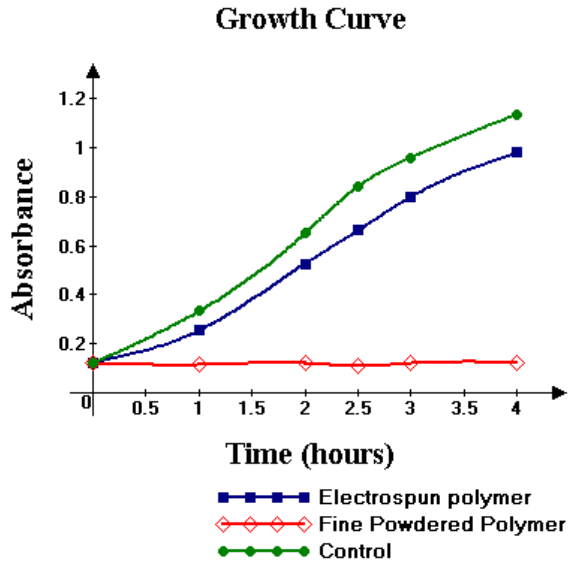




Colloids and Surfaces B: Biointerfaces 178 (2019) 8–21

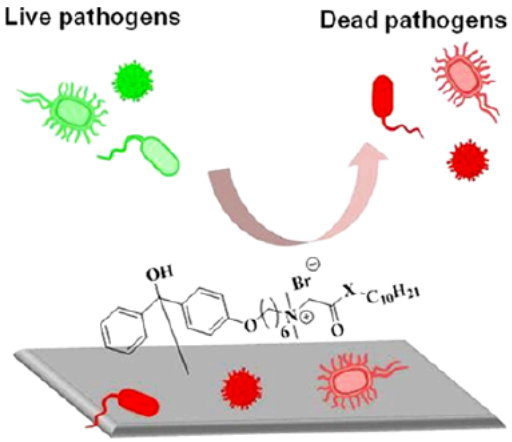
Superhydrophobic Antimicrobial Coating





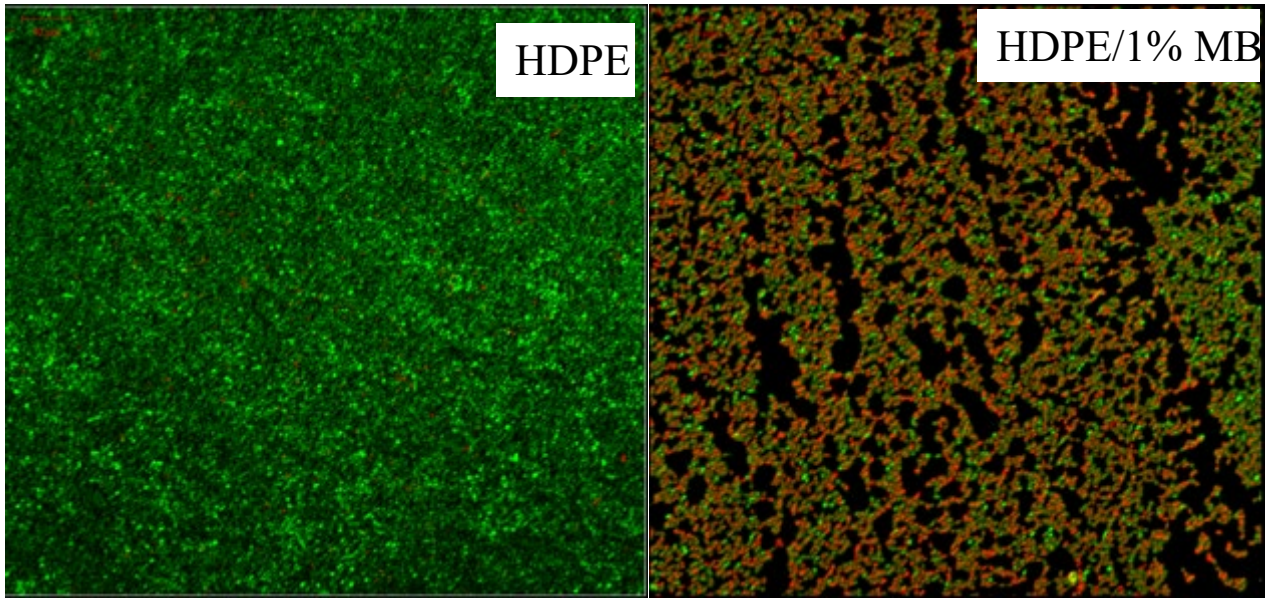
Types of antimicrobial surfaces and coatings

- Polymers that are inherently antimicrobial
- Incorporation of agents directly into polymers/paints as additives
- Immobilization of antimicrobials to polymers by ion or covalent bond
- Coating or adsorbing antimicrobials onto surfaces



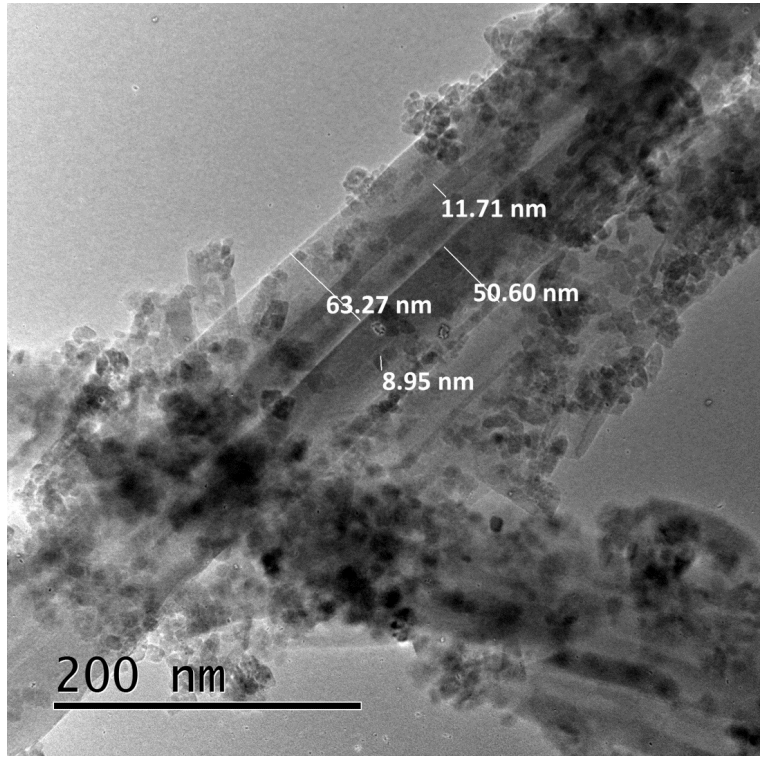
Antimicrobial surface:

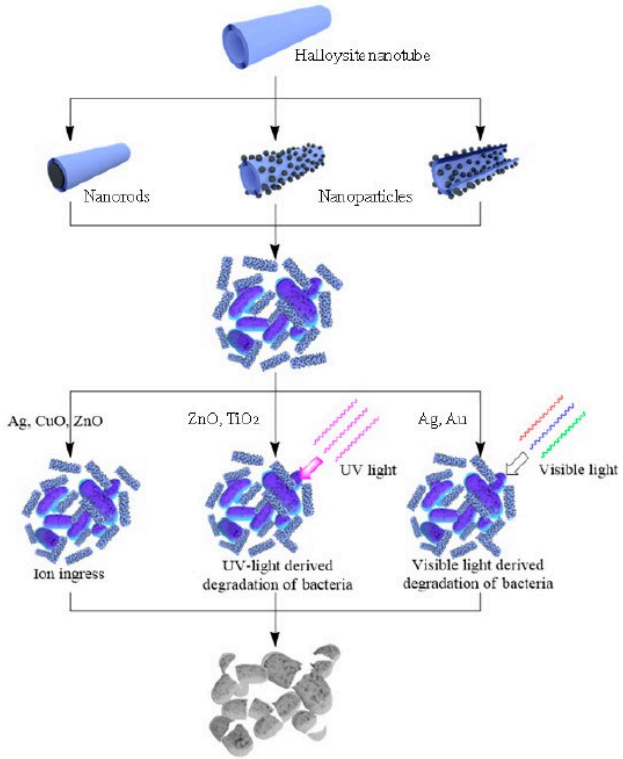
- **Easy synthesis**
- **Covalently coated from water and organo solution**
- **Complete killing of bacteria, fungi and virus**

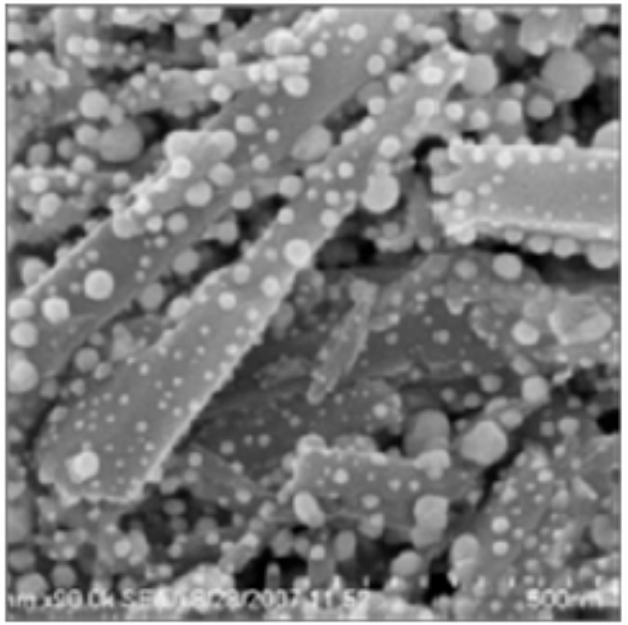


Incorporation of agents directly into polymers as additives

- Typical example is; Ag, TiO_2 anatase, ZnO, CuO substituted zeolites/clays most widely used as polymer additives
- These substituted zeolites/clays are incorporated into polymers like polyethylene, polypropylene, nylon and butadiene styrene at levels of 1-3%.





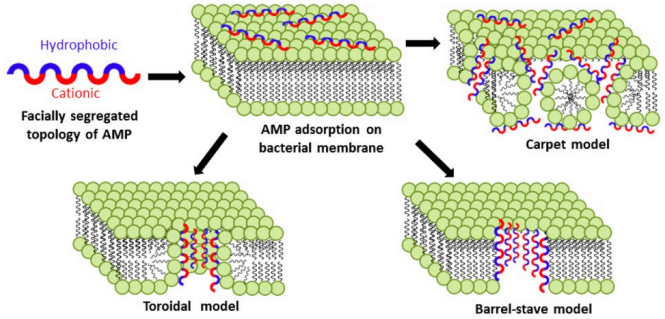


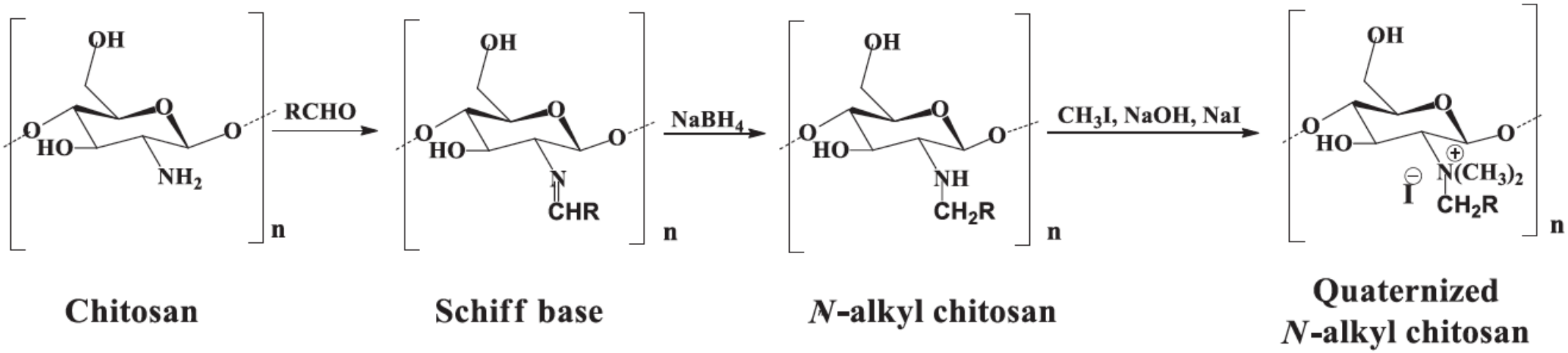
Nanoparticles

- The AgNPs of different sizes and concentrations were tested against SARS-CoV-2, it was shown that nanoparticles of diameter around 10 nm are effective between 1 and 10 ppm, while cytotoxic effect for cells was observed at concentrations of 20 ppm and above and can directly bind to viral proteins.
- Cuprous oxide (Cu_2O), cupric oxide (CuO), cuprous sulfide (Cu_2S) and cupric sulfide (CuS) were tested as antiviral surfaces against bacteriophages T4 and Qβ., Five viruses of different biochemical and structural compositions were successfully inactivated by copper (II).
- ZnO materials are able to release Zn^{2+} ions and also to absorb UV–Vis light and split the elements of water, producing different types of reactive oxygen species (ROS) such as superoxides, hydroxyl radicals, and hydrogen peroxide, which apparently damage lipids, proteins, carbohydrates and DNA
- Photocatalytic inactivation of virus with titanium based surfaces considers the role of complex photooxidants, such as the hydroxyl radical (•OH), the superoxide radical ($O2•^-$), and hydrogen peroxide (H_2O_2), etc.
- Carbon nanostructures, such as graphene, showed a possible application in the fabrication of coatings with photothermal effect.

Inherently Antimicrobial Polymers: Chitosan

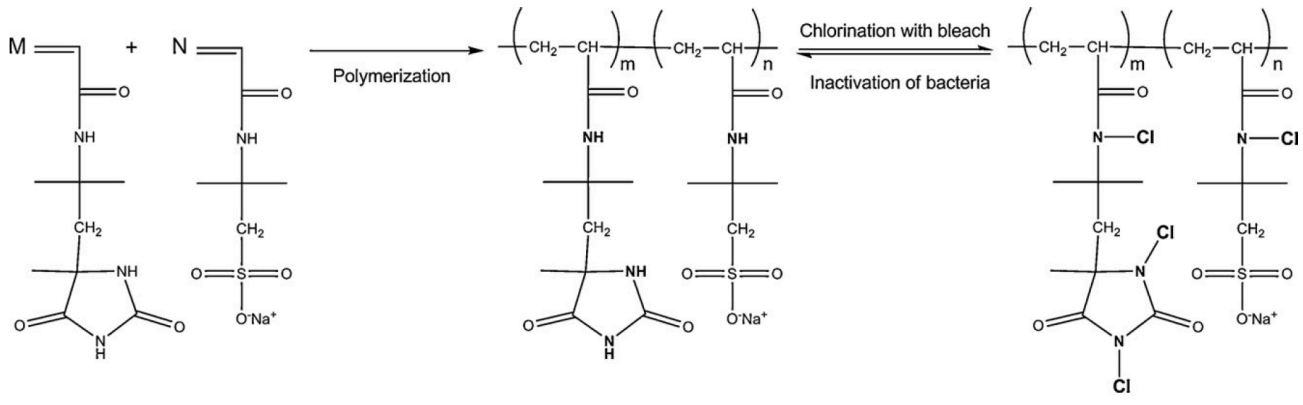
- Chitosan on the surface of the cell can form a polymer membrane, which prevents nutrients from entering the cell.
- Chitosan of lower MW enters the cell through pervasion.
- Since chitosan could adsorb the electronegative substance in the cell and flocculate them, it disturbs the physiological activities of the bacteria and kills them





N-Halamine polymers

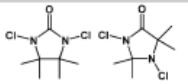
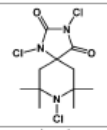
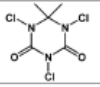
N-halamineacrylamide monomer capable of stabilizing 31 wt % of chlorine was described



Scheme 1. Structure of the synthesized polymers.

Chemical Reviews

Table 1. Classification, Structure, Antibacterial Property, and Application for Some Typical *N*-Hala

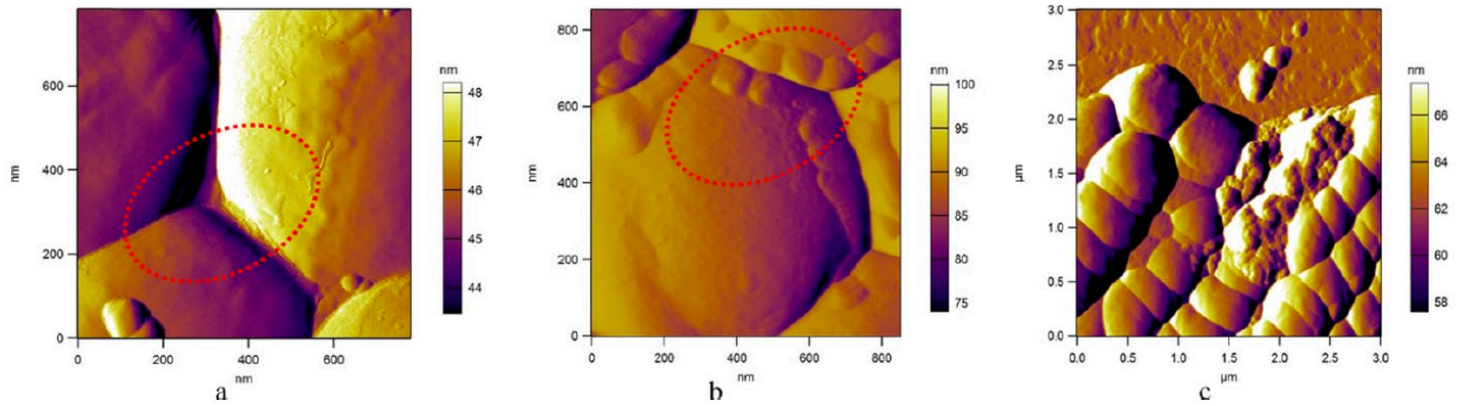
Classification	Name	Structure	Antibacterial property	Application	Reference
Cyclic *N*-halamines	Hydantoin-containing *N*-halamines		Excellent antimicrobials; Stable and durable under washing and UVA irradiation; Rechargeable via a post-treatment with dilute chlorine solution	Water treatment; Textile materials; Dyes and paints; Paper; Stainless steel; Silica materials	54-82
	Imidazolidinone -containing *N*-halamines		Regular antibacterial property; Quite stable against repeated laundering; Durable and refreshable with chlorine bleaching	Air purification; Textile materials	83-94
	Oxazolidinone -containing *N*-halamines		Excellent and rapid antimicrobials; Effective against both Gram-negative and Gram-positive bacteria	Textile materials; Silica materials	95-106
	Succinimide-containing *N*-halamines		Regular antimicrobials; Biofouling control	Water treatment	107-109
	4-Piperidinol -containing *N*-halamines		Superior antimicrobial efficacy; Contact antibacterial; Durable and rechargeable; Excellent thermal and hydrolytic stability	Textile materials; Medical and healthcare products; Dyes and paints; Silica materials	110-118
	1,3,8-Triazaspiro[4.5] -decane-2,4-dione-containing *N*-halamines		Biocidal against both Gram-positive and Gram-negative bacteria; Very resistant to loss of the halogen through hydrolyses	Textile materials; Silica materials	119-122
	1,3,5-Triazinane-2,4-dione-containing *N*-halamines		Biocide with a brief contact time; Great stability and rechargeability	Textile materials	123,124
	Barbituric acid-containing *N*-halamines		Excellent antibacterial against both Gram-positive and Gram-negative bacteria; Fast antibacterial speed	Water treatment; Silica materials	125-130
	Cyanuric acid-containing *N*-halamines		Excellent antimicrobial efficacy against Gram-positive and Gram-negative bacteria; Good biocompatible; Durable, stabile and rechargeable	Water treatment	131-136
Acyclic *N*-halamines	Inorganic *N*-halamines	NH_2Cl, $NHCl_2$, NCl_3	Weak antimicrobials; Strong dependence on circumstances	Water treatment	49,137-139
	Amine *N*-halamines		Regular antibacterial property; Easily transformable in chlorine-containing systems	Water treatment	109,140-143

Coating or adsorbing antimicrobials onto surfaces

Sabancı Üniversitesi

non coated glass

coated glass



S. aureus cell on glass substrate

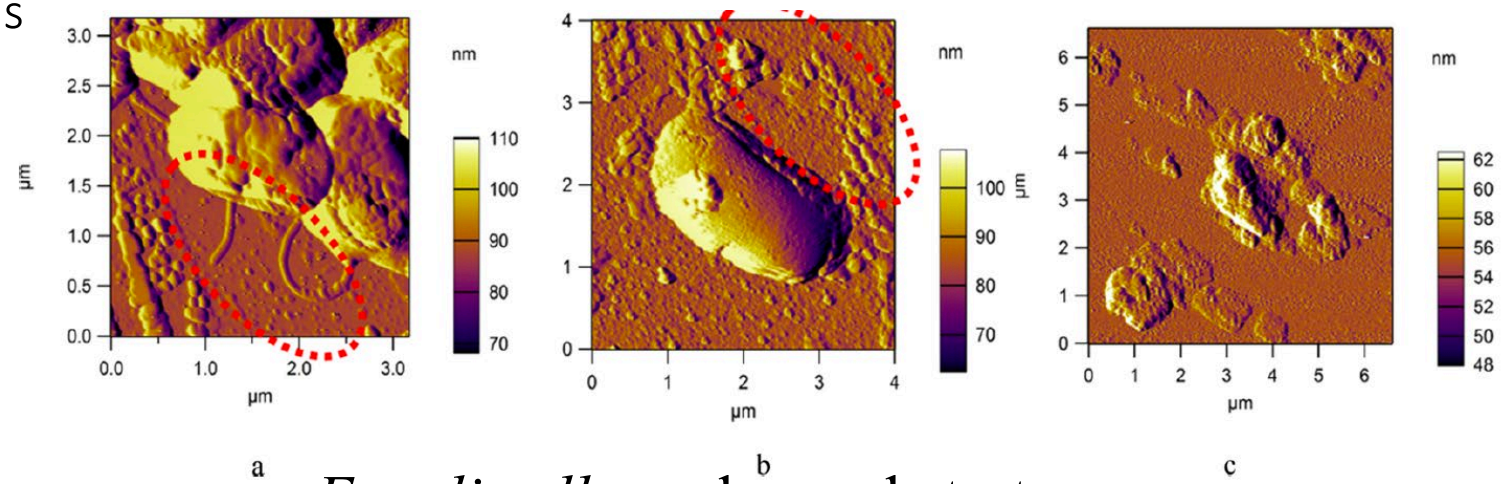
minimally 0.45 at.% of alkylated nitrogen at a binding energy of around 401.3 eV is required

N1s Scan B

N1s Scan A

non coated glass

coated glass



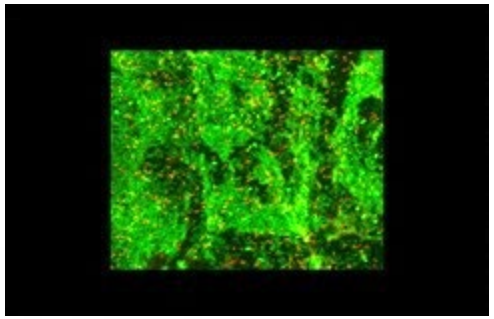
E. coli cell on glass substrate

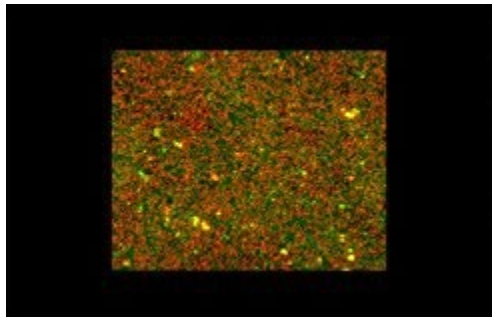
Langmuir 2018, 34, 4750–4761

Antimic EPDM rubber wheel

Örnek	*S. aureus* ATCC 6538 Mikrobiyal yük *kob/ml 24.saat	% Öldürme Oranı 24.saat	R değeri 24.saat
1B Kauçuk (EPDM + %3 Antimic Uygulanmış Örnek)	< 10	> 99,99	4.81
Antimic Uygulanmamış Örnek [1A, Kauçuk (EPDM)] (Kontrol)	$1.20x10^5$ (0. saat) / $6.60x10^5$ (24.saat)	———	———
Bakteri Kontrol	$1,80 x10^5$		

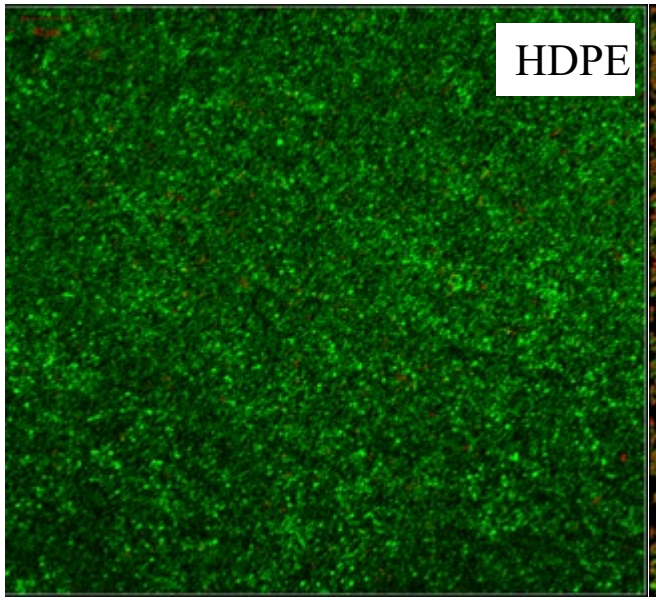
Örnek	*E. coli* ATCC 8739 Mikrobiyal yük *kob/ml 24.saat	% Öldürme Oranı 24.saat	R değeri 24.saat
1B Kauçuk (EPDM + %3 Antimic Uygulanmış Örnek)	< 10	> 99,99	4.30
Antimic Uygulanmamış Örnek [1A, Kauçuk (EPDM)] (Kontrol)	$1.63 x10^5$ / $2.00x10^5$		
Bakteri Kontrol	$4.55 x10^5$		

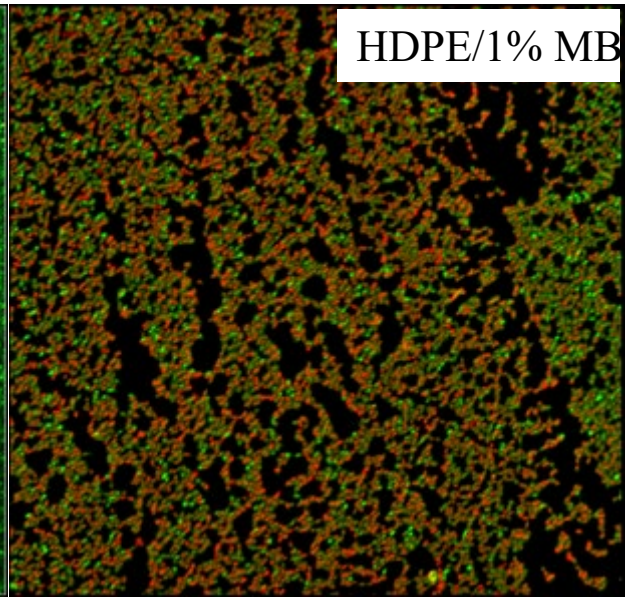


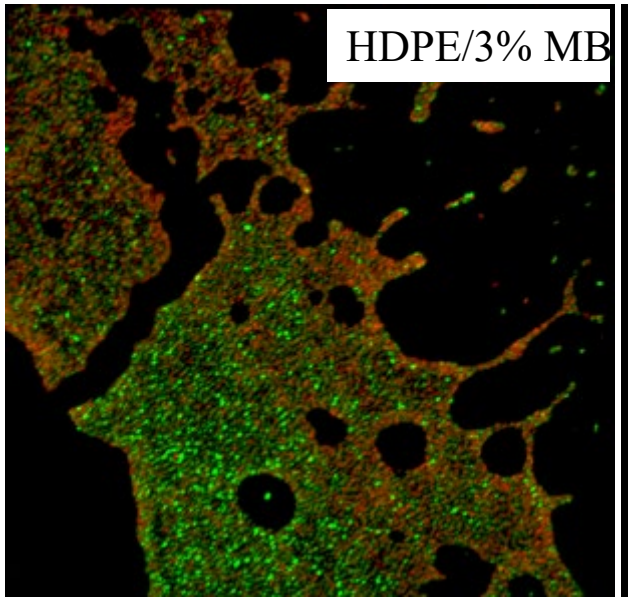


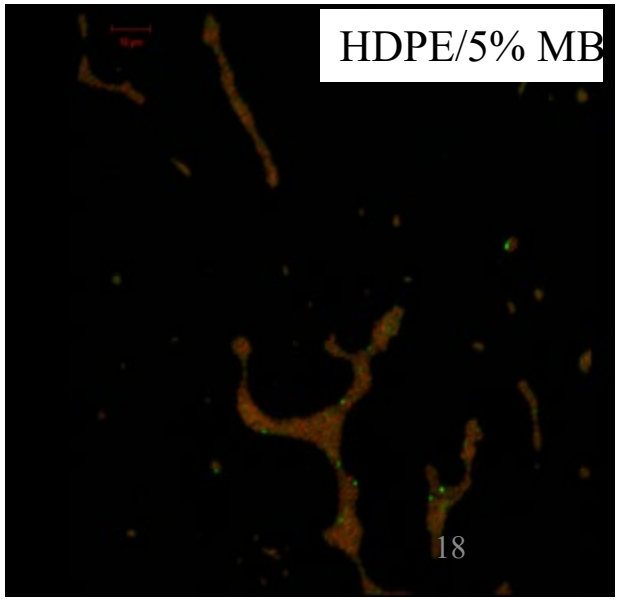
Steel is made with Antimic Anti-Bacteria powder coating

Antimic HDPE Pseudomonas 24h









CTP Hygienic Panels

Healthcare buildings walls and ceiling

MİKROBİYOLOJİK ANALİZ RAPORU

ANTİMİC UYGULANMIŞ CAM ELYAF TAKVİYELİ POLYESTER (CTP) ÖRNEKLERİNİN KANTİTATİF (JIS Z 2801:2000 ANTIMICROBIAL PRODUCTS-TEST FOR ANTIMICROBIAL ACTIVITY AND EFFICACY) TEST METODU İLE ANTİBAKTERİYEL ETKİNLİĞİNİN DEĞERLENDİRİLMESİ

Tablo 1. Antimic uygulanmış cam elyaf takviyeli polyester (ctp) örneklerinin *S. aureus* bakterilerine karşı etkinliği

Örnek	*S. aureus* ATCC 6538 Mikrobiyal yük *kob/ml 24.saat		% Öldürme Oranı	R değeri
Sprey Antimic Uygulanmış Örnek	< 10		99,99	4.14
Antimic Uygulanmamış Örnek (Kontrol)	$1,14 \times 10^5$ (0. saat)	$1,40 \times 10^5$ (24. saat)		-
Bakteri Kontrol	$1,36 \times 10^5$			

*kob: koloni oluşturan birim

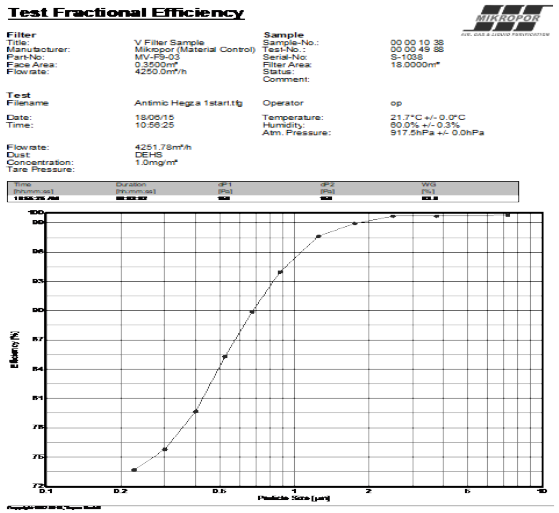
Tablo 2. Antimic uygulanmış cam elyaf takviyeli polyester (ctp) örneklerinin *E. coli* bakterilerine karşı etkinliği

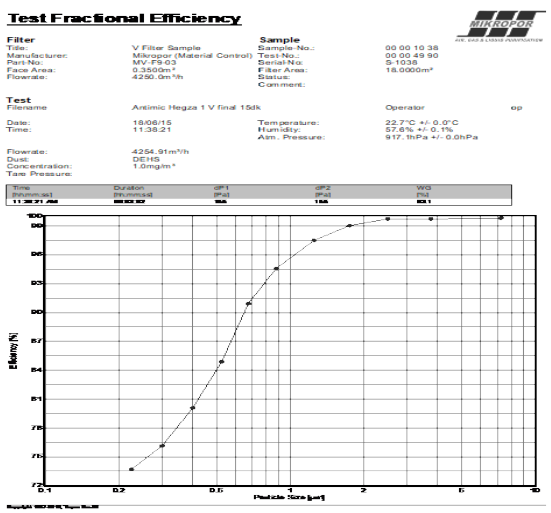
Örnek	*E. coli* ATCC 8739 Mikrobiyal yük *kob/ml 24.saat		% Öldürme Oranı	R değeri
Sprey Antimic Uygulanmış Örnek	< 10		99,99	4.91
Antimic Uygulanmamış Örnek (Kontrol)	$3,55 \times 10^5$ (0. saat)	$8,20 \times 10^5$ (24. saat)		-
Bakteri Kontrol	$3,33 \times 10^5$			

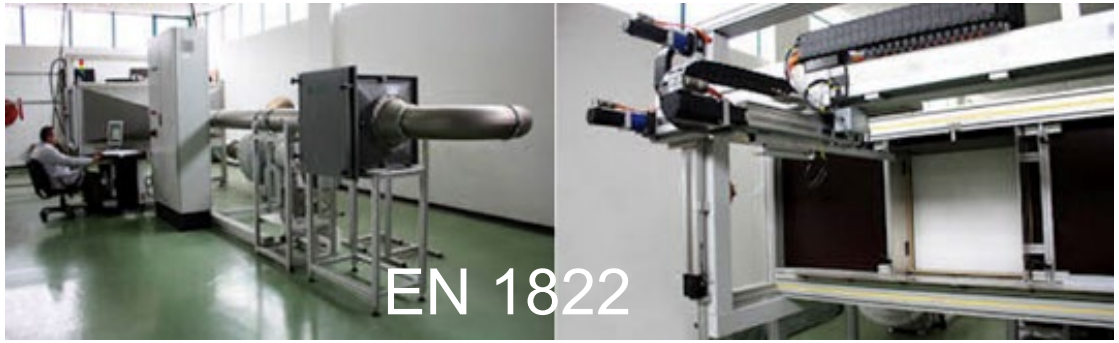
Tablo 3. Antimic uygulanmış cam elyaf takviyeli polyester (ctp) örneklerinin *S. aureus* bakterilerine karşı etkinliği

Örnek	*L. pneumophila* ATCC 33152** Mikrobiyal yük *kob/ml 24.saat		% Öldürme Oranı	R değeri
Sprey Antimic Uygulanmış Örnek	< 10		99,99	4.88
Antimic Uygulanmamış Örnek (Kontrol)	$2,55 \times 10^5$ (0. saat)	$7,60 \times 10^5$ (24. saat)		-
Bakteri Kontrol	$2,97 \times 10^5$			

** Bu standart *S. aureus* ve *E. coli* bakterileri için tasarlanmıştır. Test materyalinin kullanım amacına yönelik olarak, *L. pneumophila* bakterisine karşı antimikrobiyal etkinliği test etmek üzere test modifiye edilmiştir.







Air Filters

mikropor

TEST SONUÇ RAPORU

DOKÜMAN NO	YÜRÜRLÜK TARİHİ	SAYFA NO	REVİZYON NO
FR-8.2.4-06	02.01.2003	1/1	00

TEST EDİLEN ÜRÜN MÜŞTERİ/TEDARİKÇİ	FİLTRE NUMUNELERİ Yusuf Mencloğlu (Sabancı Üniversitesi)
TEST TARİHİ	18.06.2015
TEST SIRA NO	15-51
TEST EDEN	Ali ALTUNBAŞ

TEST SONUÇLARI:

Numune gelen Antimic Hepza 1 kodlu (Bakteri, Virüs, Küf ve Mantarlara karşı koruyucu) spreyin filtre materyalleri üzerindeki verim ve fark basınç etkileşim testleri yapıldı.

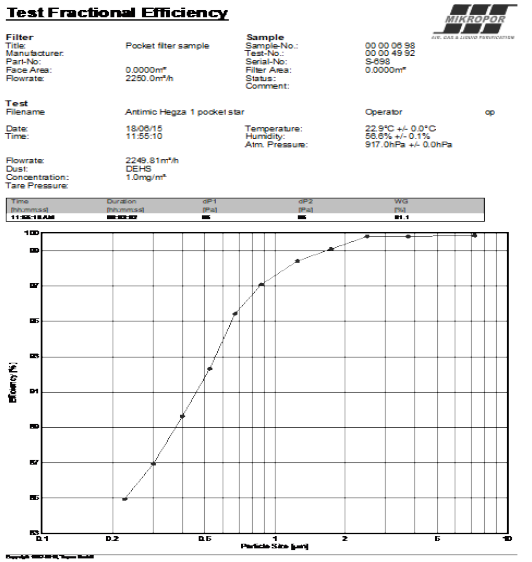
Test sonuçları tablodaki gibidir.

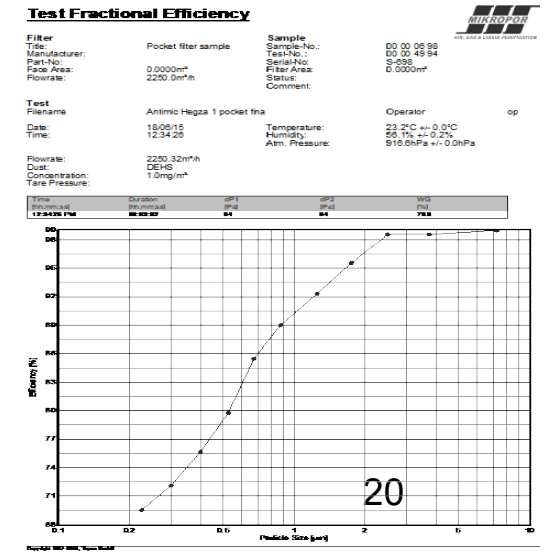
Filtre	Test Debisi (m3/h)	Başlangıç 0,4Mic. Verimi (%)	Başlangıç Fark Basıncı (pa)	Uygulama sonrası 0,4Mic. Verimi (%)	Uygulama sonrası Fark Basıncı (pa)
MV-F9-03-18m2	4250	79,8	159	80,2	156
HFN-610/610/70-14GD	600	-	132	-	132
MPS-8-8-600-03G	2250	89,7	95	75,8	94

Test sonuçlarına göre cam elyaf filtrelerin (V ,Hepa) verim ve fark basınç değerlerinde uygulama sonrası değişiklik görülmemiştir.
Ancak sentetik esaslı filtrenin (pocket) fark basıncında uygulama sonrası değişiklik görülmezken, verim değerinde düşme görülmüştür.

Testlerle ilgili grafikler eklerdedir.

HAZIRLAYAN	ONAY
Ali ALTUNBAŞ	





AATCC Test Method 100-2004, Antibacterial Finishes on Textile Materials:Assesment of % reduction of *Legionella pneumophila*

Sabancı Üniversitesi

Sample	Control	Bacterial number	Kill Rate %
Polyester (0. hour contact with *L. pneumophila*)	4.75×10^5	5.33×10^4	88.76
Polyester (1 hour contact with *L. pneumophila*)	4.75×10^5	<100	> 99.978
Polyester (24 hour contact with *L. pneumophila*)	4.75×10^5	<100	> 99.978
Glass fiber (0. hour contact with *L. pneumophila*)	5.25×10^5	6.85×10^4	86.94
Glass fiber (1 hour contact with *L. pneumophila*)	5.25×10^5	<100	>99.98
Glass fiber (24 hour contact with *L. pneumophila*)	5.25×10^5	<100	>99.98

Summary

- Self-disinfecting surfaces could minimize the impact of poor cleaning and disinfecting practices during routine and terminal room cleaning and disinfection.
- Self-disinfecting surfaces show clear advantages over the regular surfaces with traditional cleaning: the state of continuous disinfection and the antimicrobial activity that permanently eliminates the microorganisms.
- Self-disinfecting surfaces have demonstrated modest killing ($\log_{10} \leq 2$ reductions in pathogens).
- Continued research in this area to discover means of reducing the impact of environmental contamination in the transmission of healthcare-associated pathogens is clearly warranted.

Sabancı Üniversitesi

Thank you for your attention

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MİKROBİYOLOJİK ANALİZ RAPORU

ANTİMİC UYGULANMIŞ SERAMİK ÖRNEKLERİNİN KANTİTATİF (JIS Z 2801:2000 ANTIMICROBIAL PRODUCTS-TEST FOR ANTIMICROBIAL ACTIVITY AND EFFICACY) TEST METODU İLE ANTİBAKTERİYEL ETKİNLİĞİNİN DEĞERLENDİRİLMESİ

Örnek	*E. coli* ATCC 8739 Mikrobiyal yük *kob/ml 24.saat	% Öldürme Oranı
0.1 N 500 Cycle Aşındırma Yapılmış Antimic Uygulanmış Örnek	< 10	99,99
0.1 N 1000 Cycle Aşındırma Yapılmış Antimic Uygulanmış Örnek	< 10	99,99
5 N 500 Cycle Aşındırma Yapılmış Antimic Uygulanmış Örnek	< 10	99,99
5 N 1000 Cycle Aşındırma Yapılmış Antimic Uygulanmış Örnek	< 10	99,99
Antimic Uygulanmış Aşındırma Yapılmamış Örnek	< 10	99,99
Antimic Uygulanmamış Örnek (Kontrol) Sarı	$5,55 \times 10^5$ (0. saat)	$5,76 \times 10^5$ (24. saat)
Antimic Uygulanmamış Örnek (Kontrol) Beyaz	$3,90 \times 10^5$ (0. saat)	$5,46 \times 10^5$ (24. saat)
Bakteri Kontrol	$5,90 \times 10^5$	

ISO 11998 yöntemine göre aşındırılıp JIS 2801:2000 yöntemi ile antimikrobiyal etkinlik

Sert, pürüzsüz Yüzeylerde kalıcı Antimikrobiyal Aktivite testi EPA Protokolü # 01-1A

Aşındırma ve Reinokülasyon Prosedürü

1- Test organizmasının ilk inokülasyonu[a]

2- Test edilecek biyositin uygulanması

3- Aşındırma siklusu kuru pamuklu bezle**

4- Aşındırma siklusu ıslak pamuklu bezle**

5- Test organizmasının reinokulasyonu[b]

6- Aşındırma siklusu kuru pamuklu bezle*

7- Aşındırma siklusu ıslak pamuklu bezle**

.....

8- Toplam 12 aşındırma ve 5 reinokülasyon

9- Biyosidal ürün uygulamasından 24 saat sonra sanitize edici testinin uygulanması

EPA test #2 indicating the effects of wear on bactericidal copper alloy

Image courtesy of Rocky Mountain Hardware

https://continuingeducation.bnpmedia.com/course.php?L=5&C=1083&P=1

EPA #01 testi, Bulgular –*S. Aureus and K. pneumoniae*

Tablo 4. SilQUAT bileşiği uygulanmış antibakteriyel seramik plakaların *S. aureus* bakterisine karşı antibakteriyel aktivitesinin EPA protokolü sanitize edici testi ile değerlendirme sonuçları

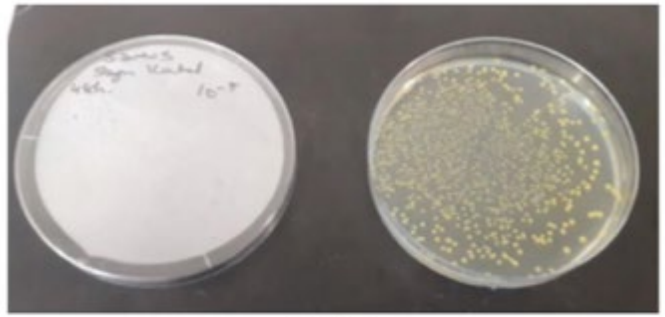
Örnek İsmi	5 Dakikalık Sanitizer Testi Sonrası Belirlenen Mikrobiyal Yük	60 Dakikalık Sanitizer Testi Sonrası Belirlenen Mikrobiyal Yük	% Düşüş
Antimic uygulanmış seramik plaka*,a	< 30[b] (log 1.47)	< 30[b] (log 1.47)	> 99.98
Tritonx100 uygulanmış seramik plaka (Negatif Kontrol)	$1{,}50 \times 10^5$ kob/ml (log 5.17)		----

*Değerler 4 plakanın geometrik ortalamasıdır
[a] Aşındırma yapılmış
[b]Plakaların son atıldığı nötralize edicinin hacminin 30 ml olması nedeniyle bu test için alt koloni limiti 30'dur. Petri plağında 0 çıkan koloniler bu nedenle 30 kabul edilmiştir.

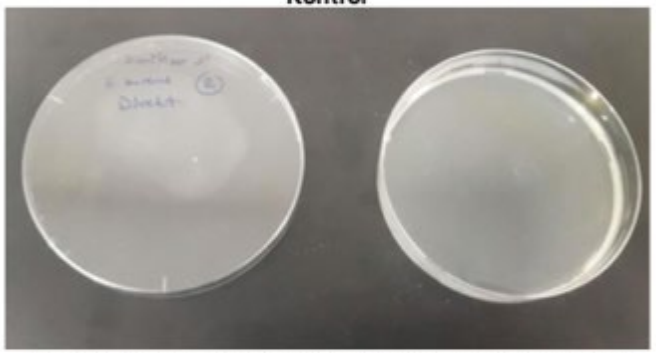
Tablo 5. SilQUAT bileşiği uygulanmış antibakteriyel seramik plakaların *K. pneumoniae* bakterisine karşı antibakteriyel aktivitesinin EPA protokolü sanitize edici testi ile değerlendirme sonuçları

Örnek İsmi	1 Dakikalık Sanitizer Testi Sonrası Belirlenen Mikrobiyal Yük	60 Dakikalık Sanitizer Testi Sonrası Belirlenen Mikrobiyal Yük	% Düşüş
Antimic uygulanmış seramik plaka*,a	< 30[b] (log 1.47)	< 30[b] (log 1.47)	> 99.97
Tritonx100 uygulanmış seramik plaka (Negatif Kontrol)	$1{,}20 \times 10^5$ kob/ml (log 5.07)		----

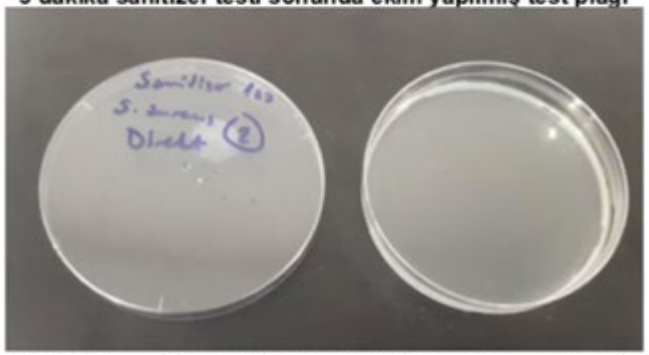
*Değerler 4 plakanın geometrik ortalamasıdır
[a] Aşındırma yapılmış
[b]Plakaların son atıldığı nötralize edicinin hacminin 30 ml olması nedeniyle bu test için alt koloni limiti 30'dur. Petri plağında 0 çıkan koloniler bu nedenle 30 kabul edilmiştir.



Kontrol



5 dakika sanitizer testi sonunda ekim yapılmış test plağı



60 dakika sanitizer testi sonunda ekim yapılmış test plağı

IAT bileşiği uygulanmış antibakteriyel seramik plakaların *S. aureus* b
aktivitesinin EPA protokolü sanitize edici testinde Petri plak koloni sa

Migrasyona uğramaz

TEST REPORT Job No./Report No TR858755 Date:17 December 2015Page 1 of 13

NANOTEGO AŞ
POLIGON MAH FEVZI ÇAKMAK CAD NO:3 İSTINYE SARıYER İSTANBUL
TEL: 05057977201
FAX: 02124858735
To the attention of Hikmet Satıcı

The following sample(s) was (were) submitted and identified by/on behalf of the client as:

Sample No.	Sample Description
A	Plastic Sample (ABS)
B	Plastic Sample (ANTIMIC ABS)

Test Parameters	Result	
Chemical tests	**A1**	**B1**
Determination of the overall migration of total non-volatile substance in plastic materials - %10 Ethanol (10 days at 20 °C)	M	M
Determination of the overall migration of total non-volatile substance in plastic materials - %3 Acetic Acid (10 days at 20 °C)	M	M
Determination of the overall migration of total non-volatile substance in plastic materials - %95 Ethanol (10 days at 20 °C)	M	M
Determination of the overall migration of total non-volatile substance in plastic materials – Isooctane (10 days at 20 °C)	M	M

Remarks	:	M = Meets client's requirement
		F = Below client's requirement
		I = Inconclusive
		* = No specified requirement
Notes:	Conclusions on meet/fail are based on the test result from the actual sampling of the received sample(s).	
	Residual sample can be returned to client if requested.	

TEST REPORT Job No./Report No TR856746 Date:28 December 2015 Page 1 of 6

NANOTEGO AŞ
POLIGON MAH FEVZI ÇAKMAK CAD NO:3 İSTINYE SARıYER İSTANBUL
TEL: 0505797720
FAX:
To the attention of Hikmet Satıcı

The following sample(s) was (were) submitted and identified by/on behalf of the client as:

Sample No.	Sample Description
A	Plastic Sample (PP)
B	Plastic Sample (ANTIMIC PP)

TEST REPORT Job No./Report No TR856746 Date:28 December 2015 Page 2 of 6

Test Parameters	Result	
Chemical tests	**A1**	**B1**
Determination of the overall migration of total non-volatile substance in plastic materials - %3 Acetic Acid (10 days at 20 °C)	M	M