ZOONO TECHNICAL OVERVIEW

CHEMICAL STRUCTURE & NOMENCLATURE

Compound (ODTA)

Octadecyldimethyl (3-trimethoxysilylpropyl) ammonium chloride

Structure

$$(HO)_3SiCH_2CH_2CH_2N^{\rho}(CH_3)_2C_{18}H_{37}\ Cl^{\sigma}$$

Note: This material is classified as an organ functional trihydroxysilane as it contains a functional organic group (quaternary nitrogen) covalently bound to a silicon atom. Organosilane denotes a minimum of one carbon-silicon bond. Trihydroxy describes the number of hydroxy groups bound to the silicon atom.

General Silane Chemistry

ODTA Prep.

$$Cl\ (CH_2)_3Si\ (OMe)_3 + C1_8H_{37}NMe_2\ \varpi \quad ODTA$$

ZOONO CHEMISTRY

Zoono is prepared as a trialkoxysilane. Trialkoxysilanes undergo a wide variety of chemical reactions including trans-esterification, acetylation, halogenation, condensation and hydrolysis to name but a few. The most important of these reactions are hydrolysis (which is used to prepare Zoono) and condensation, (which is required for Zoono to bond to surfaces and form polymeric films). class=Section2>

Hydrolysis of ODTA to Zoono

A. On contact with water molecules, the methoxy groups attached to the silicon atom in the ODTA molecule will react in a step-wise manner to form silanols.

$$(CH_3O)_3Si(CH_2)_3N^{\rho}(CH_3)_2C_{18}H_{37}\ Cl^{\sigma} + H_2O\ 6\ (\ HO)_3Si(CH_2)_3N^{\rho}(CH_3)_2C_{18}H_{37}\ Cl^{\sigma} + MeOH$$

(In dilute aqueous solution, a stable solution is formed).

ZOONO CHEMISTRY – Contd…

B. The Silanol moieties are very reactive and will react through a condensation type reaction with a wide variety of hydroxylated surfaces including cellulose, metals, sand, silica, zeolites, etc.

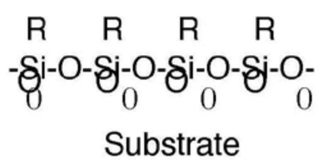
<u>substrate</u>OH! + TRISILANOL 6 substrate!O!Si(OH)$_2$(CH$_2$)$_3$N$^{\rho}$ (CH$_3$)$_2$C$_{18}$H$_{37}$ Cl$^{\sigma}$
+ H_2O

C. Silanol containing Zoono undergo autocondensation reactions with other Silanol substituted Zoono molecules and with the surface of a substrate, eliminating water.

OH OH OH R OH
RSi(OH)$_3$ + RSi(OH)$_3$ 6 RSi-O-SiR 6 RS i-O(Si-O)$_n$-SiR *
OH OH OH OH OH

Autocondensation occurs across the surface of substrates to produce 3-dimensional, cross-linked polymers being on the average 10-30 molecules thick, depending on the substrate.

Drying after application produces a durable, non-leaching, bonded, antimicrobial surface.



*where R = C$_{18}$H$_{37}$N$^{\rho}$(CH$_3$)$_2$CH$_2$CH$_2$CH$_2$! Cl$^{\sigma}$

GENERAL REACTIVITY OF ZOONO

Bonding and Deposition on Surfaces

Zoono will react with oxide and hydroxyl containing surfaces through a condensation reaction. The bonds formed are covalent and are resistant to re-hydration. Coatings on siliceous materials (glass, sand) are removed by thermal means (>250°C) or concentrated chemical treatment (KOH, NaOH, HF). Durable coatings on metal are dependent on the metal substrate.

Zoono coatings have been applied to textile fibres including cotton, cellulose acetate, polyester, nylon, wool, rayon, acrylon, etc.

Bonding and Deposition on Surfaces – Contd…

Durable coatings are readily applied to various natural and plastic surfaces including cotton, cellulose, wool, nylon, PVC, polyester, rayon, etc. Evaporation of the application media promotes T-resin film formation on the substrate.

Electrostatic or H-bonding interactions provide bonding. Uniform film formation occurs through even "wetting" of the plastic surface. Durable films are achieved on nylon, fibreglass, epoxy, polyester, PVC substrates. Less durable films are obtained on PE and PP. Film formation on PTFE and other fluorinated substrates have not been reported.

GENERAL ZOONO ANTIMICROBIAL CHEMISTRY

Zoono is a unique antimicrobial material.

It forms a water stable solution at low concentrations. There are no additives in Zoono added to promote stability. This solution has the antimicrobial properties of typical aqueous solutions of quaternary ammonium compounds.

On application to surfaces, the material reacts to produce a bonded antimicrobial coating. On evaporation of the water solvent, a durable bonded coating is produced which has improved and sustained antimicrobial properties.

Zoono, when applied to a surface, transforms from a water soluble monomeric species to an insoluble, macromolecular antimicrobial film.

This film is stable and durable.

Zoono has been demonstrated effective against a wide range of pathogens.

APPENDIX ONE

The following table lists the pathogens that are killed or inactivated following application of Zoono to various substrates and materials.

This table does not reflect the activity of Zoono in the liquid form.

Pathogens Inactivated By Zoono Application

Gram Positive Bacteria	Reference
Bacillus sp. (vegetative cell)	5, 6, 11
Corynebacterium diptheriae	1, 13
Micrococcus lutea	5, 6, 11
Micrococcus s p.	2, 5, 15
Mycobacterium tuberculosis	14, 36
Mycobacterium smegmatis	14
Propionibacterium acnes	5
Staphylococcus aureus *	2, 3, 5, 6, 10, 11, 13, 24, 15, 21
Staphylococcus epidermidis	2, 5, 6, 7, 11, 13, 14, 15
Streptococcus faecalis	2, 5, 6, 7, 11, 13, 14
Streptococcus mutans	5, 6, 7, 11
Streptococcus pneumonia	1
Streptococcus pyogenes	5, 6, 7, 11

Gram Negative Bacteria	Reference
Acinetobacter calcoaceticus	2, 5, 6, 11, 14, 15
Aeromonas hydrophilia	5, 6, 11
Citrobacter deversus	5, 6, 11
Citrobacter freundi	5, 6, 11
Enterobacter aerogenes	5, 6, 7, 11
Enterobacter aglomerans	2, 5, 14, 15
Enterobacter cloacae	5, 6, 7, 11
Enterococcus	10
Escherichia coli	1, 2, 3, 5, 6, 7, 10, 11, 13, 14
Klebsiella oxytoca	5, 6, 11, 14
Klebsiella pneumoniae	3, 5, 6, 7, 9, 10, 11, 13, 14
Klebsiella terriena	19
Legionella pneumophila	1
Morganella morganii	5, 6, 7, 11
Proteus mirabilis	5, 6, 7, 11
Proteus vulgaris	5, 6, 7, 11
Pseudomonas aeruginosa	2, 3, 5, 6, 7, 11, 13, 14
Pseudomonas fluorscens	5, 6, 7, 10, 11
Salmonella cholera suis	5, 6, 7, 11, 14
Salmonella typhi	5, 6, 7, 11, 14
Salmonella typhimurium	1, 5, 6, 7, 11
Serratia liquifaciens	5, 6, 7, 11
Serratia marcescens	5, 6, 7, 11
Xanthomonas campestris	5, 6, 7, 11

Contd…

Viruses	**Reference**
Adenovirus Type II & IV	17, 18, 21
Bovine Adenovirus Type I & IV	17, 18, 21
Feline pneumonitis	21
Herpes Simplex Type I	16, 17, 18
Herpes Simplex Type II	21
HIV-1 (AIDS)	21
Influenza A2 (Aichi)	17, 18, 21
Influenza A2 (Asian)	17, 18
Influenza B	17, 18
Mumps	17, 18
Parinfluenza (Sendai)	21
Rous S arcoma	17, 18
Reovirus Type I	17, 18
Simian Virus 40	17, 18
Vaccinia	17, 18
MS2	19
PRD1	19
H1N1 (Swine Flu)	34
Norovirus	35
Middle East Respiratory Syndrome (MERS)	37
Ebola ** (See Note)	38

Fungi, Algae, Mould, Yeast, Spores	**Reference**
Alterania alternate	8,12
Aphanizomenon s p.	22
Aspergillus flavus	2, 5, 6, 7, 11, 14
Aspergillus niger	2, 5, 6, 7, 8, 11, 12, 13, 14
Aspergillus sydowi	5, 6, 7, 11
Aspergillus terreus	5, 6, 7, 11, 14
Aspergillus versicolor	2, 5, 6, 7, 11
Aspergillus verrucaria	14
Aureobasidium pullans	5, 6, 7, 8, 11, 12
Candida albicans	1, 2, 5, 6, 7, 14
Candida pseudotropocalis	5, 6, 7, 11
Chaetomium globsum	1
Cladosporium cladosporioides	8, 12
Chlorella vulgaris	19
Dreschslera australiensis	8, 12
Epidermophyton s p.	9
Gliomastix cerealis	8, 12
Gloeophyllum trabeum	5, 6, 7, 11
Microsporum s p.	9
Microsporum audouinii	21
Monilia grisea	8, 12
Oscillatoria	20
Penicillium chrysogenum	5, 6, 7, 11
Pencillium commune	8, 12
Penicillium funiculosum	1, 2, 5, 6, 7, 11, 14
Penicillium pinophilium	5, 6, 7, 11

Contd…

Fungi, Algae, Mould, Yeast, Spores	**Reference**
Penicillium variable	5, 6, 7, 11, 14
Phoma fimeti	8, 12
Pithomyces chartarum	8, 12
Poria placenta	5, 6, 7, 11
Scenedesmus	20
Saccharonyces cerevisiae	5, 6, 7, 11, 13, 14
Scolecobasidium humicola	8, 12
Selenastrum s p.	22
Trichoderma viride	5, 6, 7, 11
Trichophyton interdigitale	2, 14
Trichophyton maidson	14
Trichophyton mentogrophytes	5, 6, 7, 9, 11
Trichophyton sp.	9

Protozoa Parasites	**Reference**
Cryptosporidium parvum (oocysts)	19

Note:
** Special formulation containing H_2O_2 + Zoono quaternary ammonium compound active

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