Bakul Superhard Material Institute National Academy of Sciences Ukraine

Ukrainian-USA Joint Venture "Marketing of Superhard Materials"

Liquid Nanometals Dispersions For Polymers Modification and Biocatalist of Microbial Fuel Cells

Nano Poland 2014

METAL NANO PARTICLES DISPERSIONS:

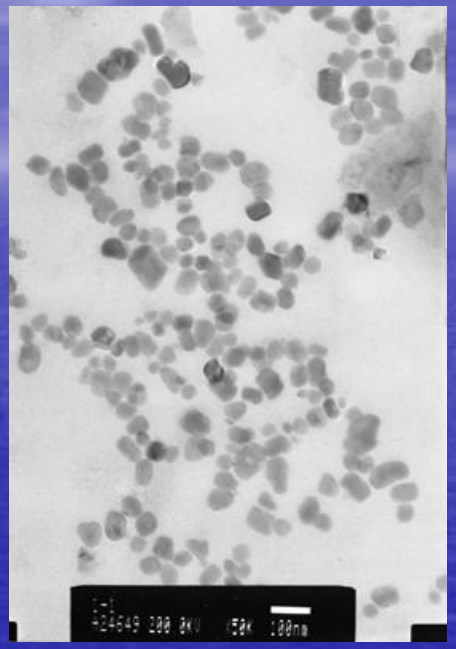
5 000 YEARS EXPERIENCE

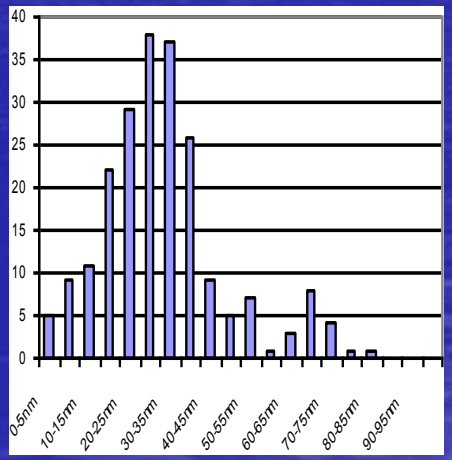
Ag

Cu

Vase dedicated by Entemena, king of Lagash (Shumer Civilization, Louvre), Silver and Copper, 2400 BC.

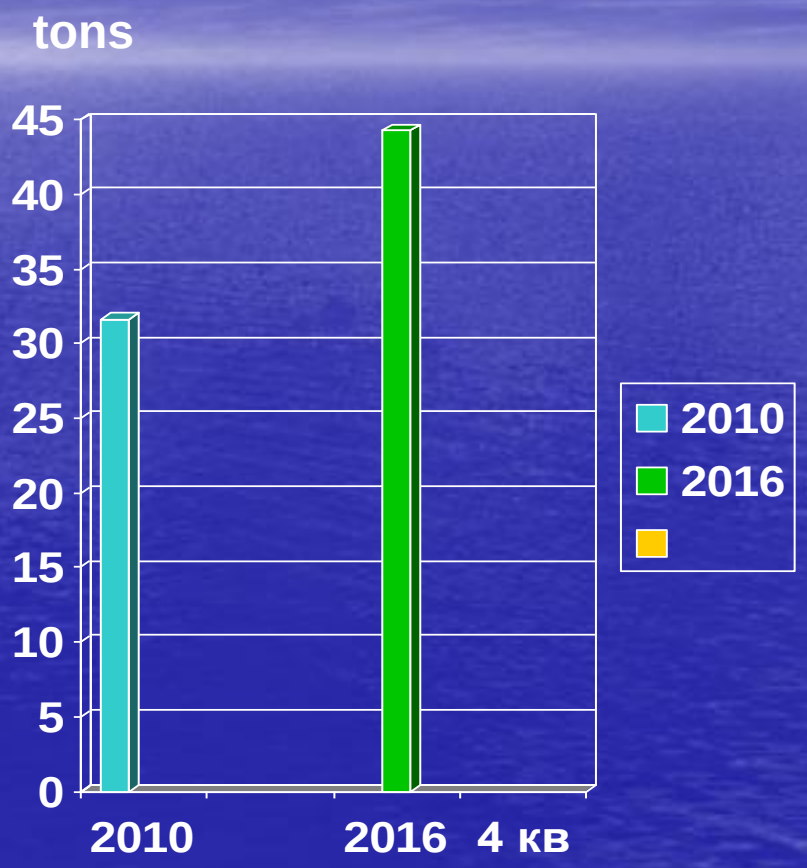
From Ion Silver to Engineered **Silver** Nano Particles Colloids





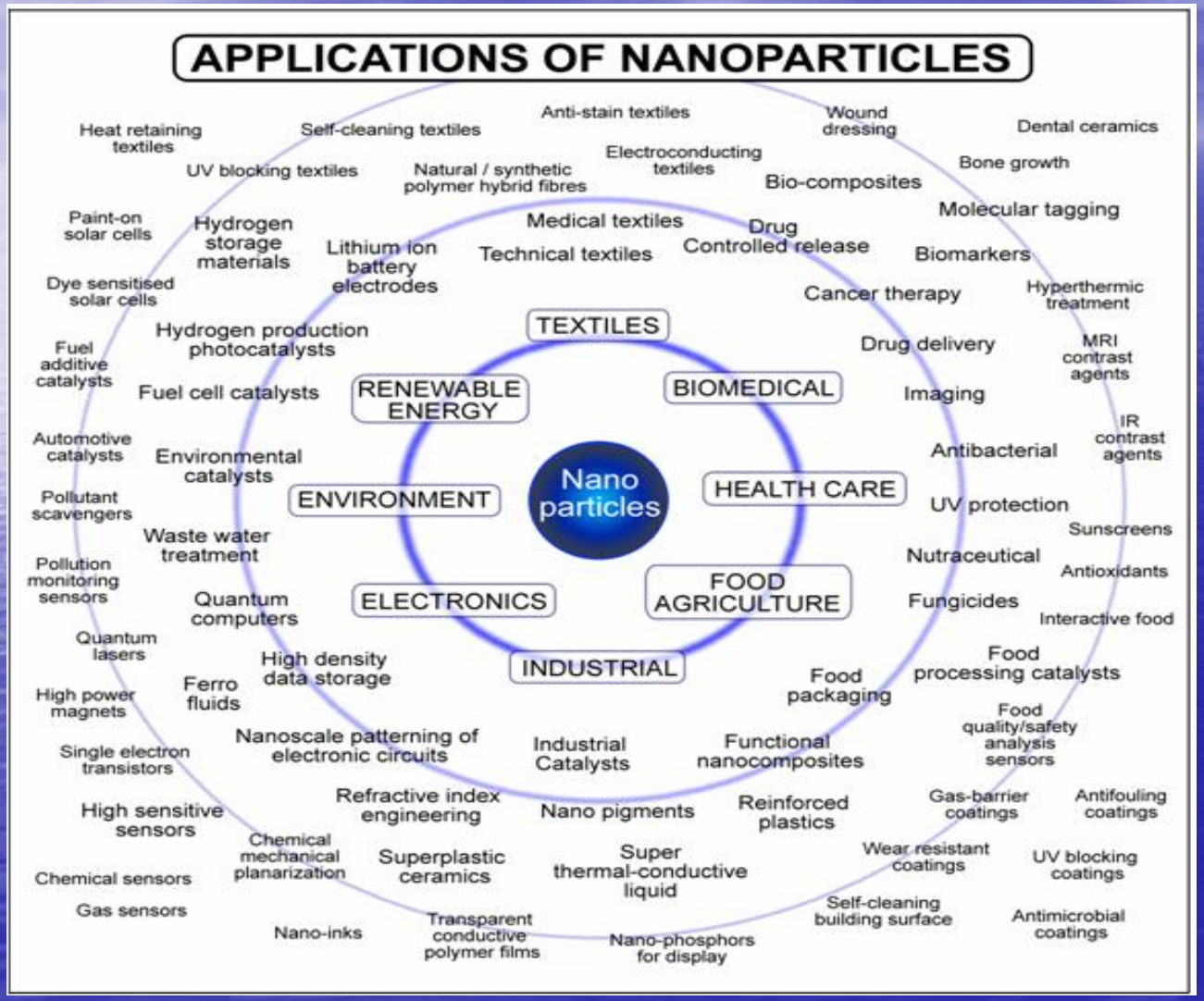
Nanometals additives – the largest group of Nanomaterials market

The most spectacular market grow among Nano metals additives was demonstrated for **Nano Silver applications**, specifically in the field of **food packaging: from $410 mill in 2010 to $5800 mill in 2012** due to substantial shelf life prolongation via high antibacterial properties



(Nanomaterials Production 2010-2016: Production Volumes, Revenues and End User Market Demand, Future Markets, Inc, 2011).

NANOPARTICLES APPLICATION



The Deakon Institute for Frontier Materials, 2009. http://www.deakin.edu.au

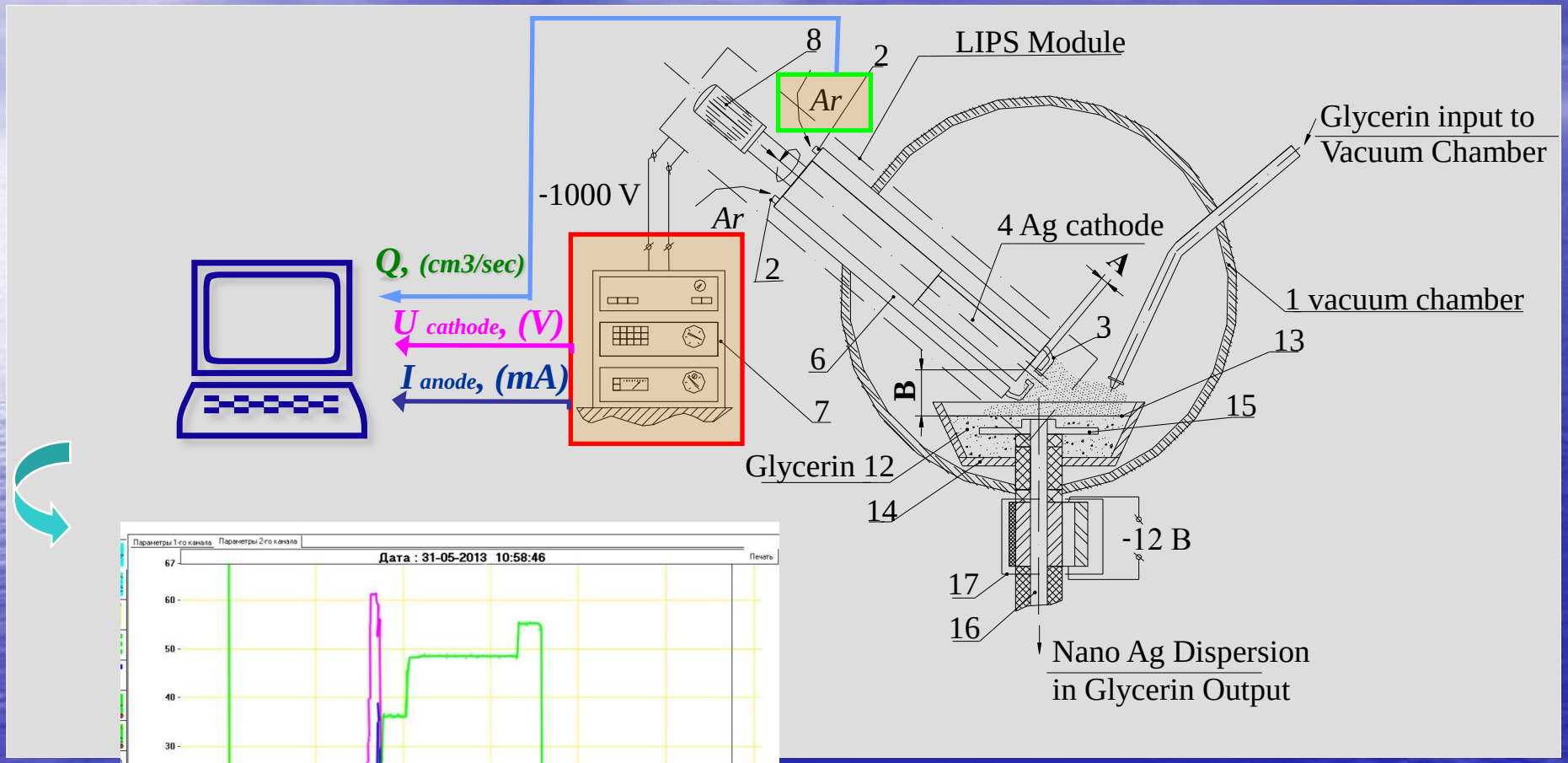
Nanometals require their dissolution in various liquids to add to the end products

To create stable homogenous solutions the size of nano particle shall be controllable

The synthesis of nano metals dispersions shall be productive in industrial scale

Nano dispersions shall be bio-compatible and eco-friendly

Combined "Dry-Wet-" Technology for Manufacturing Ultra Clean Concentrated Nano Metals Dispersions in Various Carrier Liquids



Controlled Size and Distribution of Nanometals Particles in Carrier Liquids

INNOVATIVE NANO PRODUCTS

CONCENTRATED NANO METALS DISPERSIONS IN VARIOUS CUSTOM CARRIER LIQUIDES MANUFACTURED BY PROPRIETORY ION-PLASMA TECHNOLOGY

Master Batch
"Silver Shield-1000"
is ready to add to end product

CONCENTRATED STABLE COLLOIDAL SOLUTION
metallic Nano Silver particles
with Glycerin

Nano particle size, distribution shape and concentration are controllable and have been certified by the best independent world laboratories

Extra Clean, Biocompatible,

Antimicrobial, Antiviral

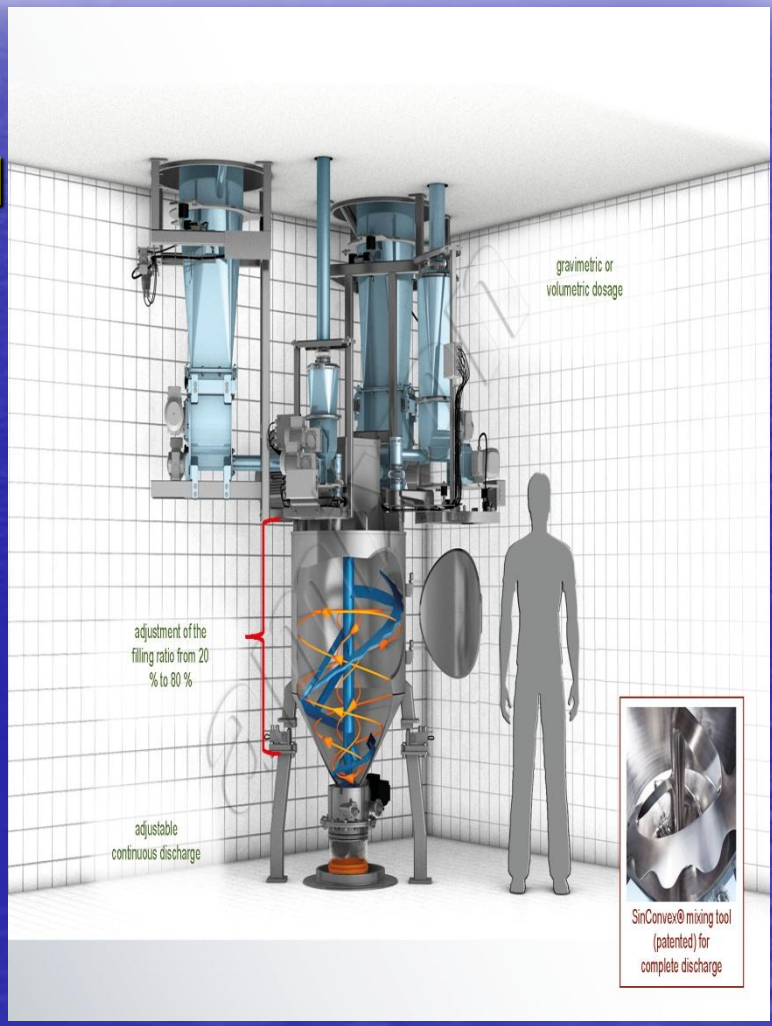
Master Batch
"NANOAGENT+"
is ready **to add to end product**
CONCENTRATED
STABLE BLEND OF CUSTOM
metallic Nano particles:
Au, Pt, Pd, Cu, Fe, Mo, Ti, etc
with
CUSTOM CARRIER LIQUIDS:
Natural or Synthetic oils, Polysaccharides, Petroleum derivatives, etc.

Conductive, Magnetic Properties

Core competence of Combined Dry-Wet Technology: One-Step Nano Particles Encapsulation in Liquid End Products Ingredients

- To encapsulate nano metal particles (Ag, Au, Pt, Pd, Fe, Cu etc.) in the **most common ingredients of the modern industrial and household end products.**

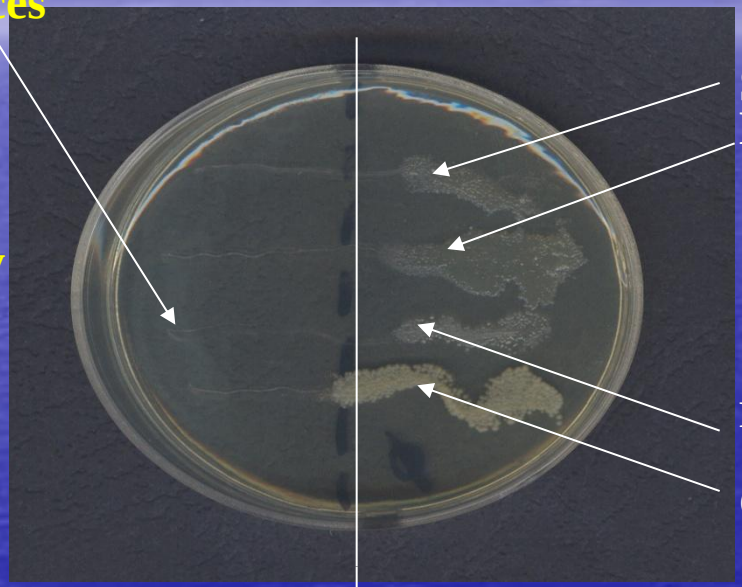
- Nano metal dispersions method of application is **mixing of modified ingredient with end products without changing traditional manufacturing processes.**



Antibacterial Property of Nano Silver Dispersion in Glycerol
"SILVER SHIELD-1000"

Disinfectant killing over 1000 Bacteria, Viruses, Fungi

Contact Surfaces Contaminated by bacteria and treated by Nano Silver disinfectant **keep sterility up to 5 days**



Staphylococcus
Escherichia coli

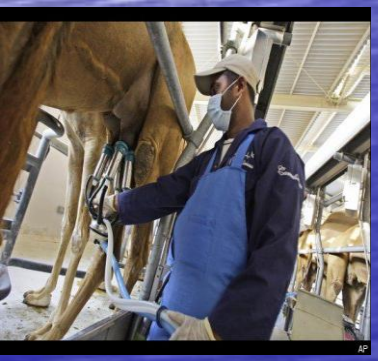
Bacteria grow on non treated surface during 5 days period

Pseudomonas aeruginosa

Candida albicans

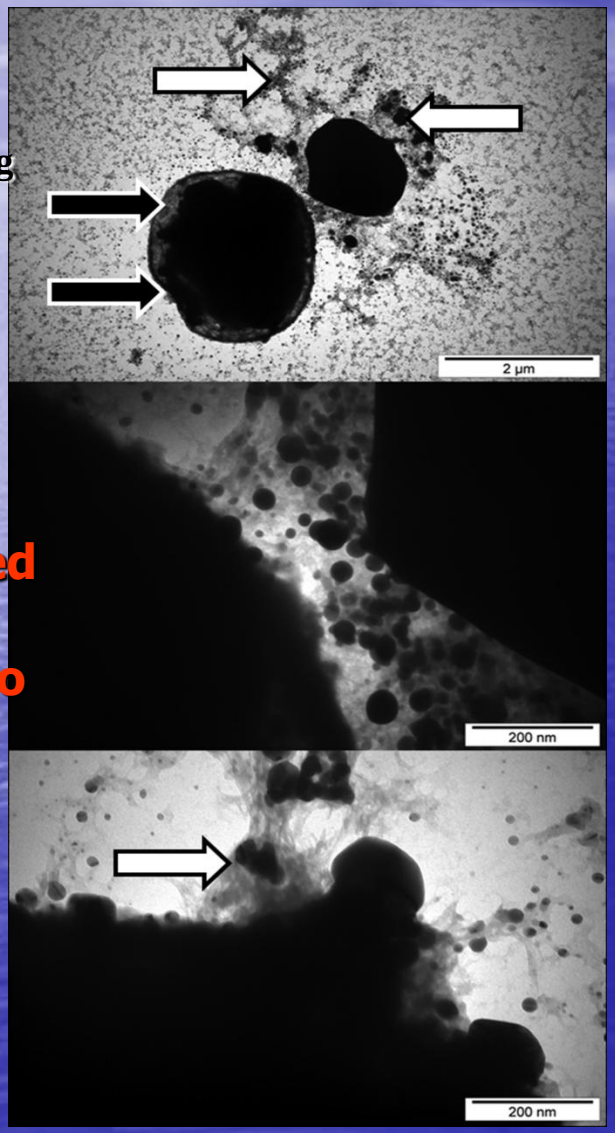
Treated with SS-1000

Non Treated with SS-1000



Fungycid Concentration for Nano Product «Nanoagent +» - custom mix of Nano Ag and Nano Cu

Ag Nano particles Surrounding micro organism



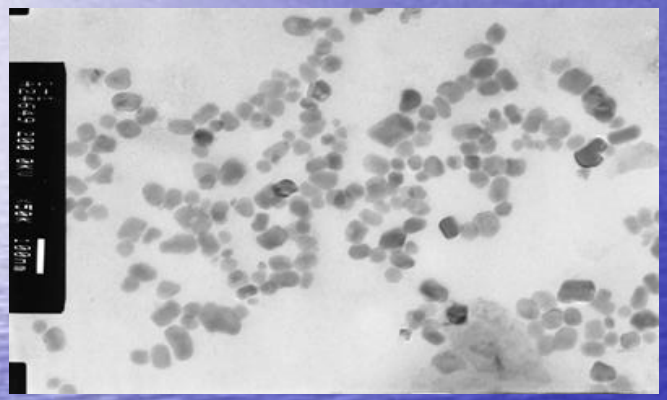
Damaged cells With cito plasma outflow

Concentration of «Nanoagent Pro» Name of Fungi	25 mkg/ml 3-rd day - No grow of Fungi cells	25 mkg/ml **4-th day** - No grow of Fungi cells	25 mkg/ml 5-th day - No grow of Fungi cells	12,5 mkg/ml 3-rd day + grow of Fungi cells
Candida utilis Lia-01-	-	-	-	+
Candida albicans УКМV2681 (ATCC101)	-	-	-	+
Zygosaccharomyces rouxii NCYC 381	-	-	-	+
Saccharomyces cerevisiae ATCC 9763-	-	-	-	+
Candida pseudotropicalis-	-	-	-	+
Aspergillus niger (field stamm)	-	-	+	+

Candida albicans

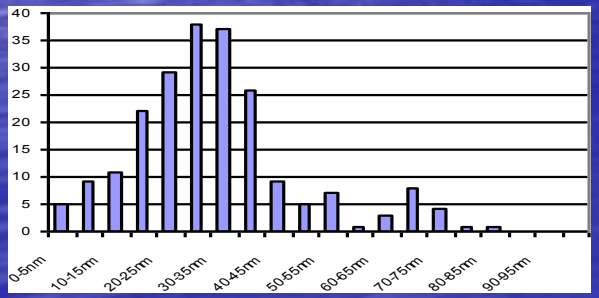
Nano modification of End Products Containing Glycerol as Ingredient by Concentrated Nano Silver Colloidal Solution in Food Glycerol "Silver Shield-1000"

Electronic microscope picture of Silver nano particles



Dispersion of

Silver nano particles



Nano modificator for

hundreds of personal care products containing glycerol as ingredients

on USA and South Korea markets

Applications of Nanomodified Polyethylene Films for Food Storage & Packaging

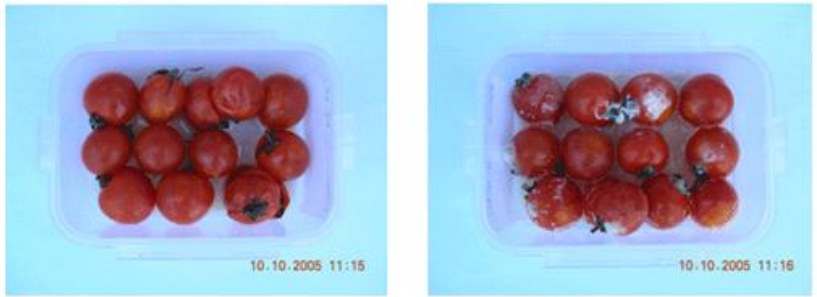
Containers and Films made from Plastic with Nano Silver additions can extend shelf life of the food

In 3-5 times

2010 Market Volume **$410 mill:**	2012 Market Volume **$5800 mill:**
Nano Silver Appl **food proc. - $100 mill;** **food package - $210 mill;** **food Ingrid - $100 mill**	**Nano Silver Appl** **food proc. -$1303 mill;** **food package -$2930mill;** **-food Ingrid - $1475 mill.**

After 2 weeks in FreshBox®

After 2 weeks in conventional container



After 2 weeks in FreshBox®

After 2 weeks in conventional container

*Nano and Biocidal Silver: Friends of the Earth Australia (http://nano.foe.org.au) Friends of the Earth United States (http://www.foe.org/healthypeople/nanotechnologycampaign)

Nano Modification of Polymer's Ingredients for Antibacterial Properties

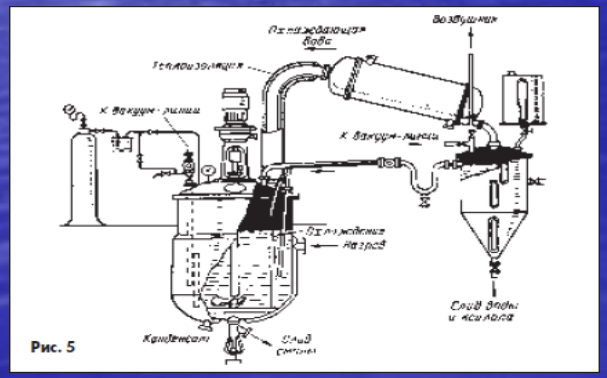
Gliftalic resins (Polyester resins) are the products of polycondensation: Nanomodified **Glycerol**

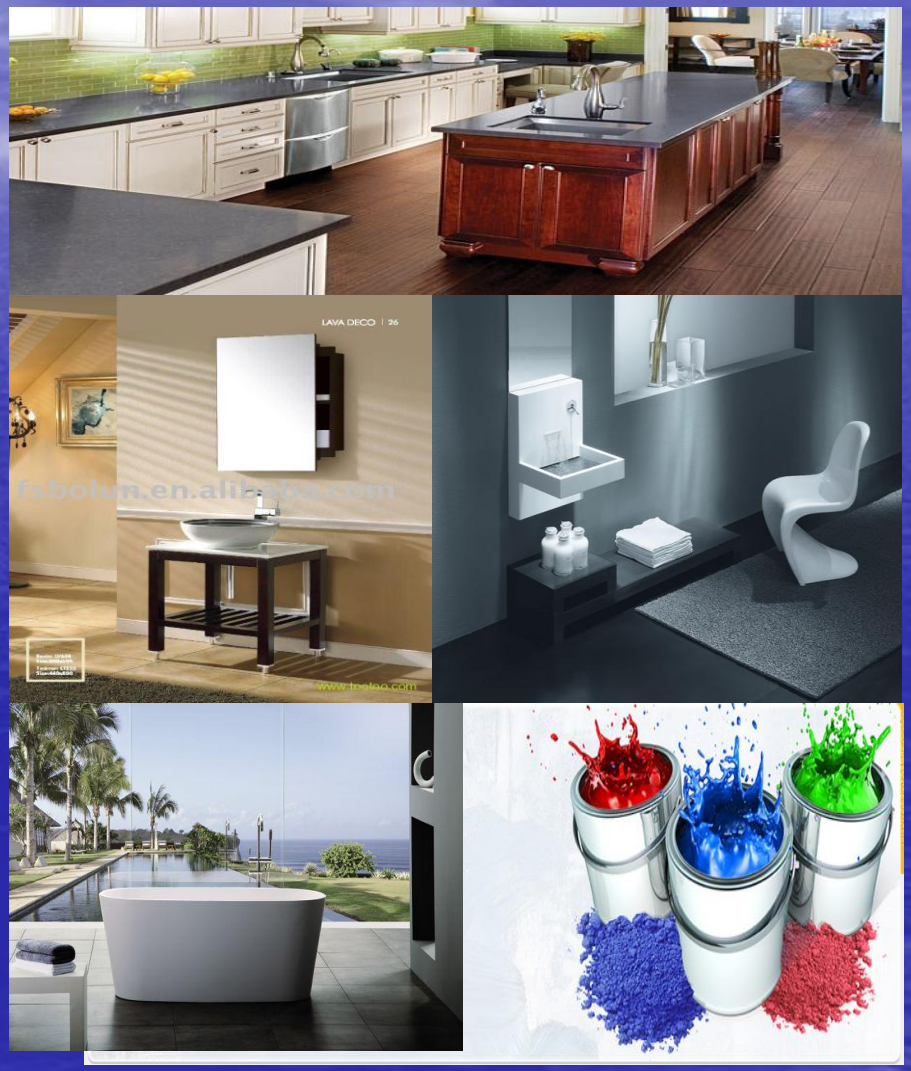
29,2 % $HOCH_2$-$CHOH$-CH_2OH

+ phthalic anhydride

70,8 % $S_8N_4O_3$

+ Nanomodified **oils**



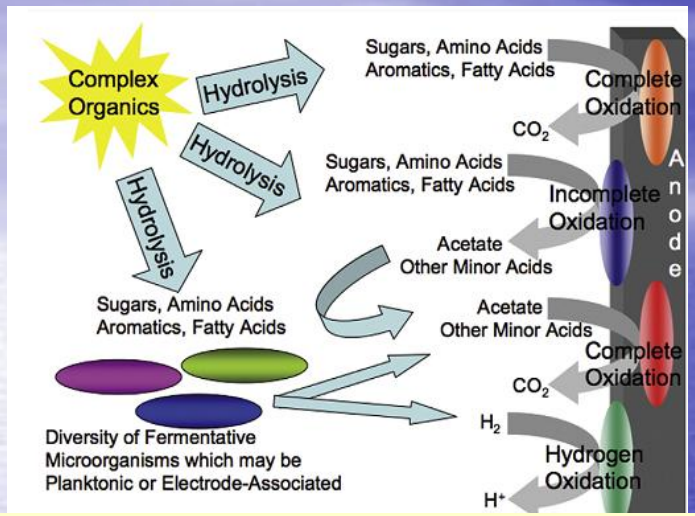


The quality-price ratio for colloidal Silver Products

Product Name & PPM on Label	PPM (from Lab Report)	Particle Surface Area cm^2/mL	Price cents/mL
Sovereign Silver 10 ppm	9.71	0.217	50,70
Ultra Pure Colloidal Silver 35 ppm	16.5	0.225	30,35
Argentyn 23 – 23 ppm	15.7	0.355	50,70
American Biotech Labs - ASAP 22 ppm	22.3	0.587	69,20
ElectraClear Colloidal Silver 10 ppm	26.4	0.662	20,74
«Silver Shield-1000» * 100ppm	100,0	0.679	12,50

Microbial fuel cells (MFCs) - new opportunities for the energy production from biodegradable compounds and wastes

Application of Nano Fe dispersion in Glycerol for MFCs Anode Nanomodification



Impregnation of anod material (Carbon fibers) with Nano Fe dispersion in Clycerol

Microbial Fuel Cell working on sea bacteria D. Acetoxidans, developed at I. Franko National University Lviv, Ukraine

Microbial Fuel Cell working on sea bacteria D. Acetoxidans used for light on POTOMAK River, WASHINGTON, USA (Tender et all., 2008)

Application of Nano Fe dispersion in Glycerol for Microbial Fuel Cell Electrode Nanomodification

Fig A. Electrodes impregnated with Nano Fe

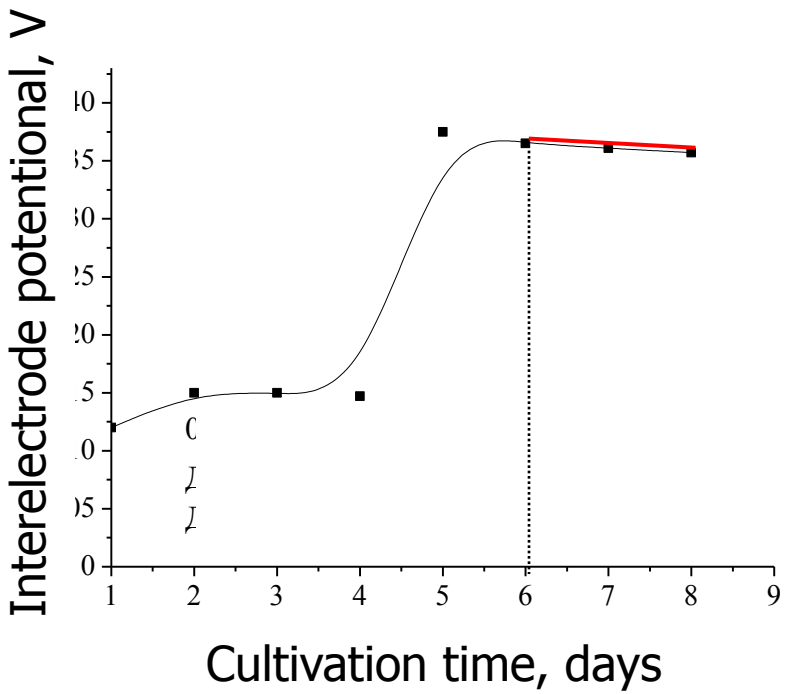
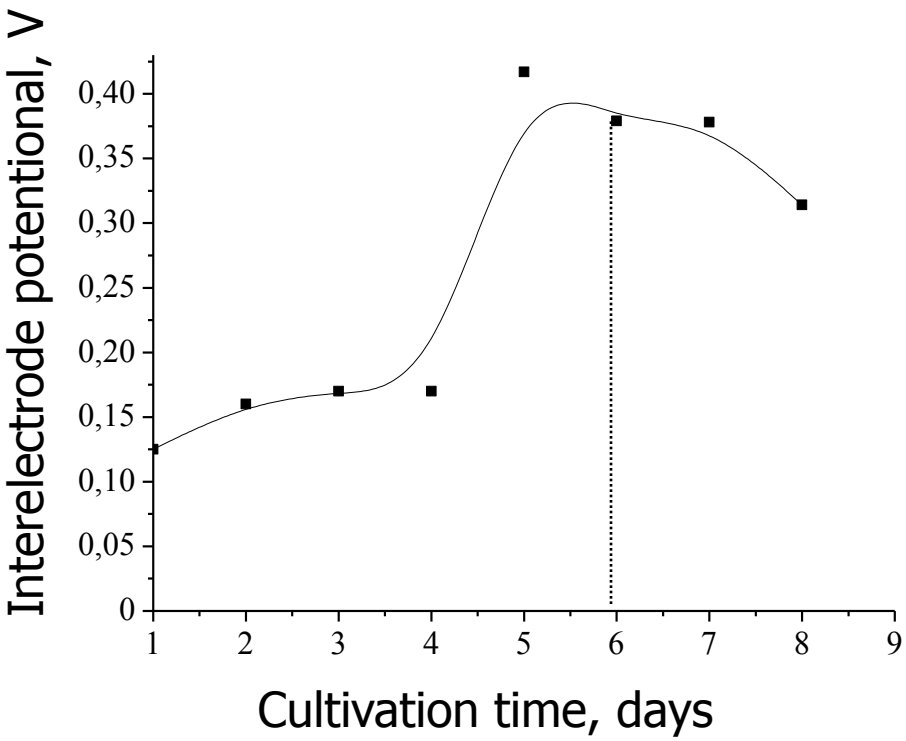


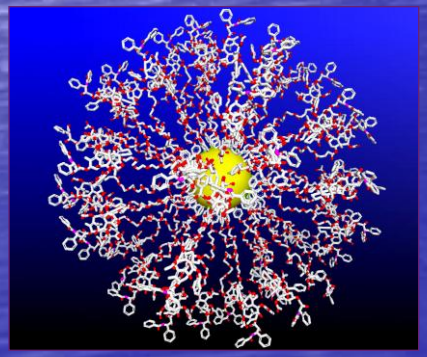
Fig A. Non treated Electrodes

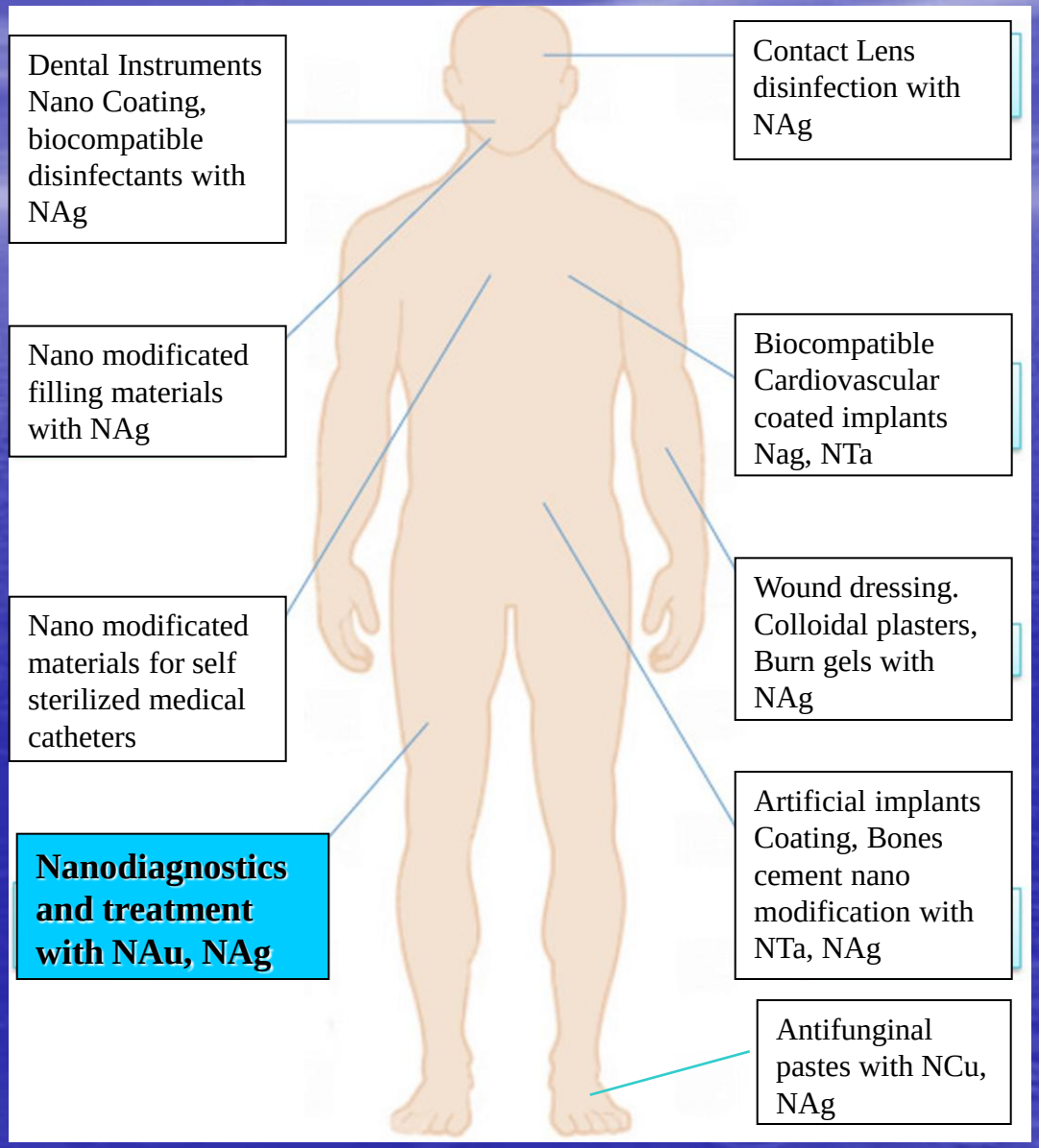


The Anode Biocatalyst with Simultaneous Transition Metals Pollution Control, Microbial Fuel Cell,p.14-20, O. Bilyy et al, Lviv, Ukraine, 2014

Bio-Medical Application of Nanomodified Materials

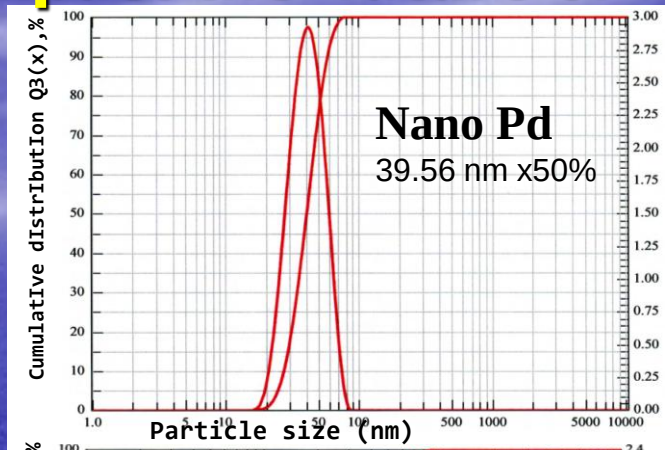
Gold is a favored material for the nano spheres, shells, rods because of its wide binding ability with biochemical functional groups and targeting to the specific type of cell

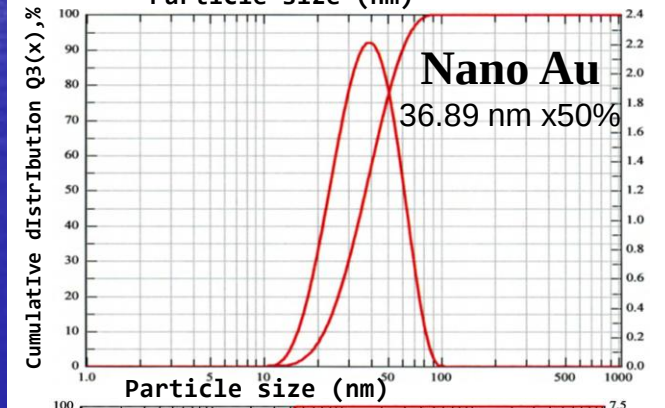


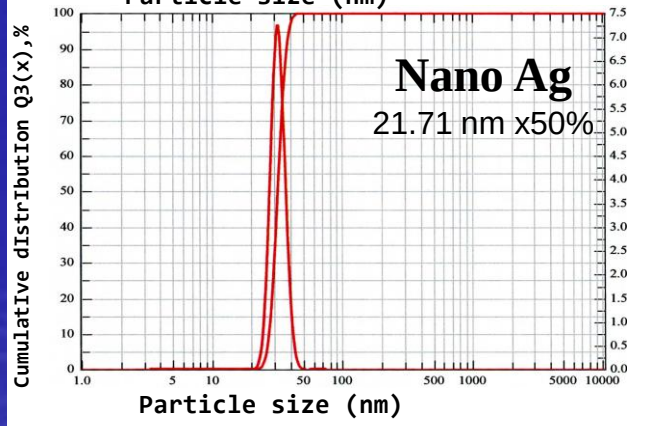


Productive Synthesis of Noble Metals Nano particles with controlled size in custom liquids will impact the future of nano medicine

Nano Product	Properties	Name Company	Packaging	Price Euro
Silver nanoparticles	40 nm 0.02 mg/mL in aqueous buffer	Sigma-Aldrich	25 mL in glass bottle	100.5
Silver nanoparticles	30 nm 500 mg/l In Food Glicerol	JV MSM. Ukraine-USA	100 ml in Poly bottle	52.00
Gold nanoparticles	10 nm diameter, OD stabilized suspension in 0.1 mM PBS	Sigma-Aldrich	25 ml in glass bottle	102.0
Gold nanoparticles	20 nm 300 mg/l	JV MSM Ukraine-USA	100 ml in Poly bottle	57.00





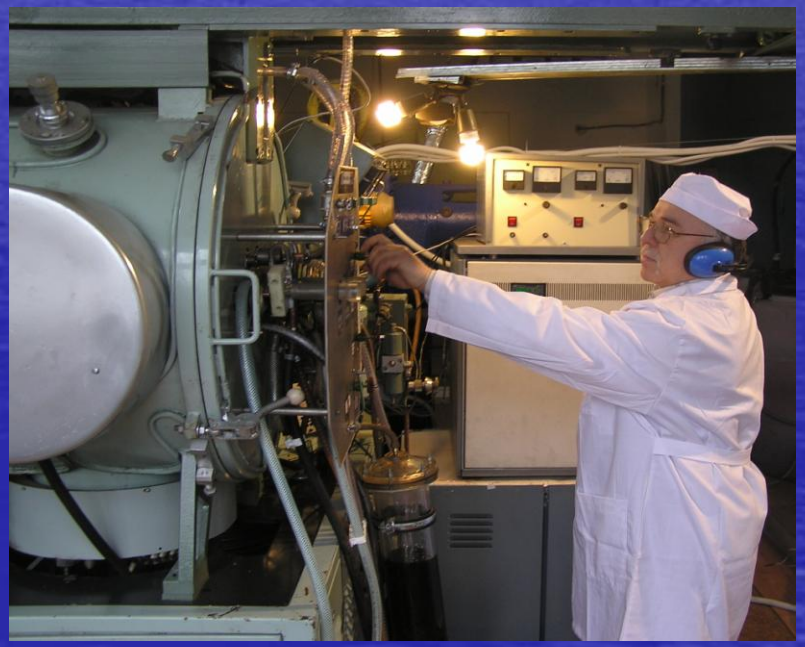


Innovative Technology and Pilot Modular Line for Concentrated Nano Metals Dispersions in Custom Carrier Liquids Manufacturing

- **What we are offering**:
- Semi-industrial Master Batches - Dispersions of Nano Silver, Nano Gold, Nano Platinum and dozens of other Nano Metals in custom liquids with the proof of the best world Labs for the quality, size, distribution, biocompatibility

- Green Technology and Know-how along with Pilot Unit for one-step productive manufacturing of highly concentrated concentrated Nano Metals Dispersions in Various Liquids: Glycerol, OILS, PLASTICS, POLYSASHARIDES, etc.

- Patented in USA, Ukraine,PCT technology for Concentrated Nano Metals Dispersions in custom Liquids Manufacturing (USA patent 5,591,313; Ukraine Patent #80513, PCT wo2008/039160 A1)



THANK YOU FOR ATTENTION

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