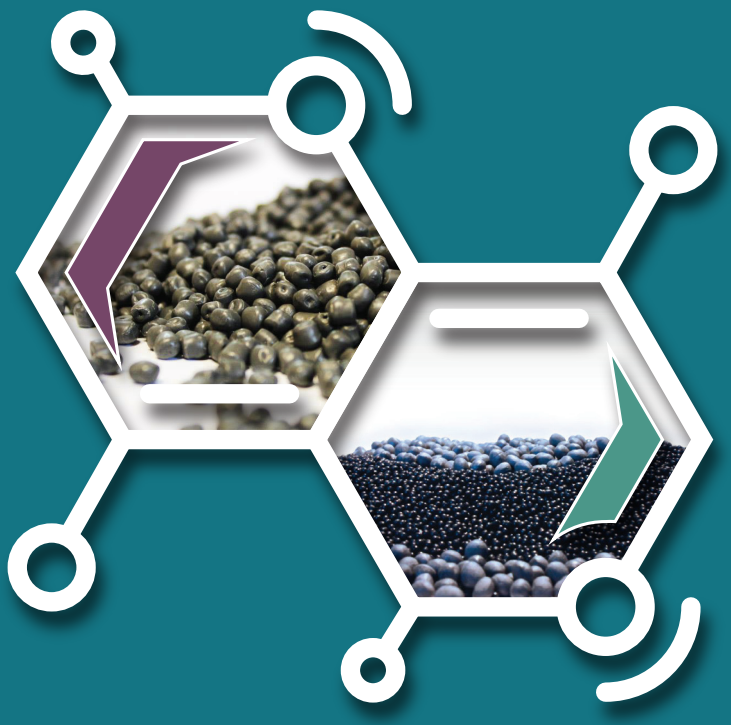
Iran Nanotechnology
Initiative Council (INIC)

A Brief Description of Iranian Nanoproducts in Polymer & Composite Industry



First Edition - 2018

• Introduction

Iran Nanotechnology Initiative Council (INIC) is responsible for supporting national policies in nanotechnology development and supervising their implementation. By providing facilities, creating market and removing the impeding obstacles, INIC aims to pave the road for private sector activity in the field of nanotechnology and generation of wealth in the country.

In the present era, innovation is very important and in the meantime, nanotechnology plays an important role in innovation. Polymer composites have been used extensively in various industries such as automobiles, buildings, agriculture and packaging, health, textile, etc. Using nanotechnology and especially nano-additive, It can be produced the intermediate materials such as nano masterbatches, nano compounds and so on which these nano- intermediate materials used for manufacturing different parts of the nanocomposite with specific and unique features. Some nanomaterials as silicon oxide, titanium dioxide, zinc oxide and carbon nanotube have been reported in polymeric materials such as polyethylene, polypropylene, polyamide, epoxy and polyester resin and etc. for improving chemical, physical and mechanical properties such as strength improvement, impact resistance, wear and corrosion reduction. In some cases in addition to improving properties, nanotechnology can reduce the cost of production.

Now more than 20 Iranian companies have managed to commercialize their nano- intermediate materials and nanotechnology products in the field of polymer composite industry. Here, in this brochure a brief introduction of some of the products is presented.

PP Based Silent Nano Masterbatch for Pipes and Fitting

Parsa Polymer Sharif Co.

PP Based Silent Nano Masterbatch has designed to improve the mechanical and sound insulation properties. It shows an increase in the elastic modulus, the yield strength and the impact resistance in the amount of 50, 15 and 80%, respectively. Pipe and fitting made with this nano compound are approved by Fraunhofer Institute, Germany, as Silent pipe with an acoustic emission as low as 15 dB.

Advantages:
- High ring stiffness
- Long-term strength
- High impact strength
- Excellent processability
- Easy handling and insulation

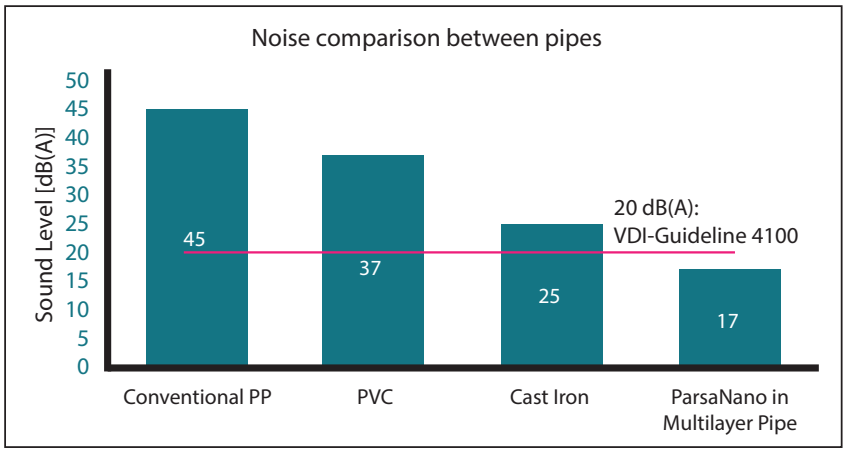
Application:
- *Noise insulated sewage pipes*
- *Hot and cold water system pipes*
- *underfloor heating system pipes*

Flame retardant pipes

Internal layer (PP):
Smooth internal surface with high wear resistance

Middle layer (ParsNano):
Resistant against noise and impact even at 0°C

External layer (PP):
Resistant against external stresses and abbration



Grade	Melt Flow Index ASTM D1238 [g/10min] (230°C, 2.16kg)	Tensile Modulus ASTM D638 [MPa]	Tensile Strenght @Yield ASTM D638 [MPa]	Charpy Impact Strength ASTM D6110 [kJ/m²] (Notched, 23°C)	Application
ParsaNano 31308	2-4	1900	18	30	Silent Fittings
ParsaNano 31310	2-4	2000	17	40	(Injection Molding)
ParsaNano 31312	0.7-0.9	2600	14	60	Silent Pipers (Extrusion)

PE Based Biodegradable Nano Compound for Food Packaging

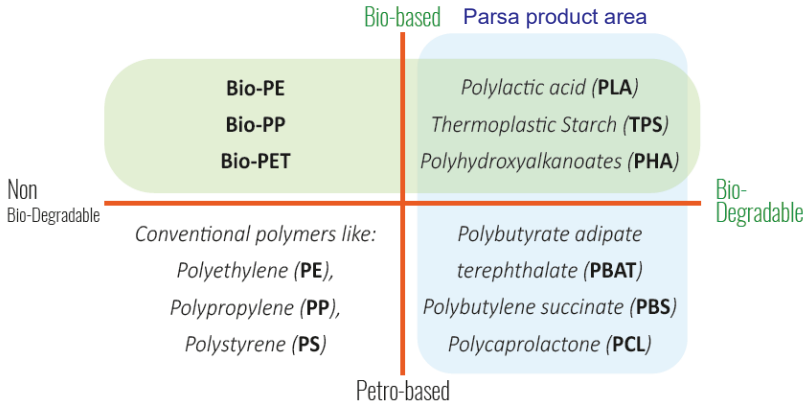
Parsa Polymer Sharif Co.

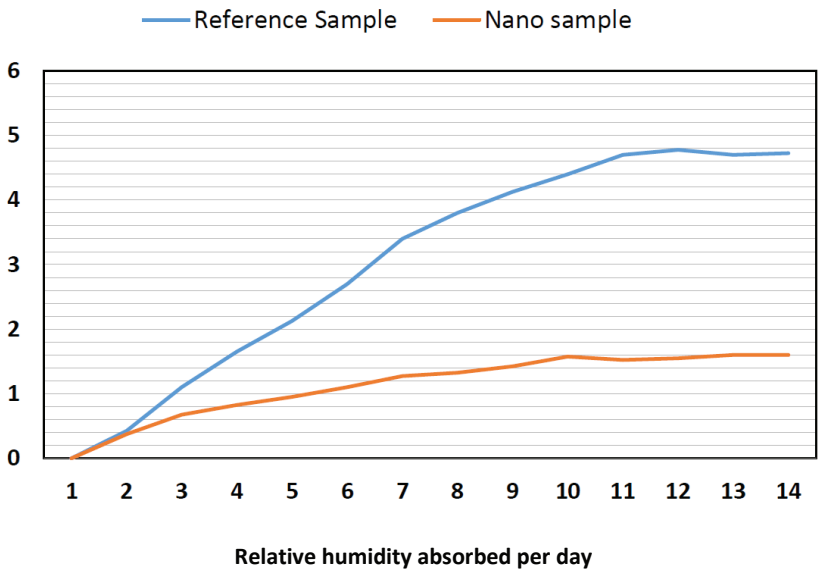
PARSA POLYMER SHARIF

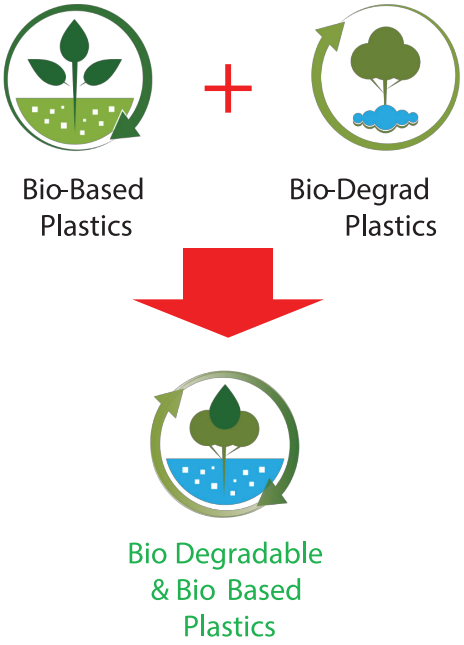
PE based biodegradable nano compound is an Eco-friendly and Bio-based materials that attracts a great deal of interest. Bio-based materials reduces the depletion of finite fossil resources and CO2 emissions.

Advantages:
- Environment friendly
- Recyclable
- Degrade up to 5 years

Applications:
- *Food packaging*
- *Shopping bags*
- *Disposable Containers*







PE based biodegradable nano compound for food packaging		
	With nano-fiber	Normal sample
The amount of CO_2 released during 45 days	0/901	0/586

Anti-Scratch Nano Masterbatch for Different Appliction

Parsa Polymer Sharif Co.
Aria Polymer Pishgam Co.

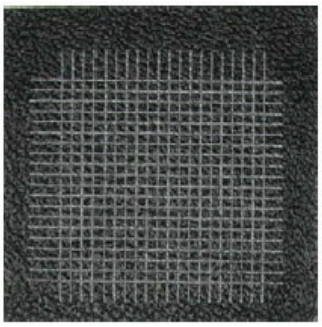
In the section of nanotechnology-based polymeric compounds, The companies produce advanced polymer compounds such as Polypropylene-based compounds with high impact and unique properties such as high scratch resistance. The Nanoparticles used to improve the resistance of polymers against scratch. These polymers are used in the production of vehicle's internal parts, home appliances, etc.

Advantages:

- High Impact strength
- Non-scratchable surface
- Good transparency properties

Applications: Automotive Dashboard

Unscratched surface



scratched without nano additive

scratched with nano additive

Antibacterial Masterbatch and Granules With Nanomaterial Additive for Different Industrial Application

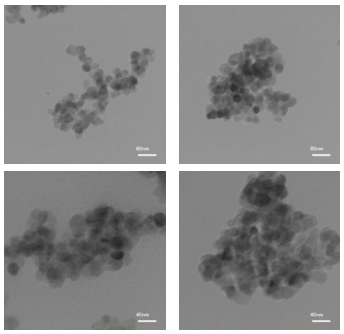
Parsa Polymer Sharif Co.
Ramo Co.

Antibacterial Masterbatch and Granules are produced based on nano additive in different polymeric matrixes. This type of antibacterial polymer are permanent and doesn't have any release and kills kind of bacteria.

Applications :
- Fabrication of antibacterial and antimicrobial pipes
- Production of plastic packages and special gloves, toys
- Polymeric components related to refrigerates, Automobile, Domestic appliances, electronic, Hospital and hygienic and Household Appliances

Polyamide with nano ZnO		
Name of bacteria	E.Coli	Staphylococus aureus
Antibacterial activity (R)	2/26	2/28

Polyethylene with nano ZnO		
Name of bacteria	E.Coli	Staphylococus aureus
Antibacterial activity (R)	2	2



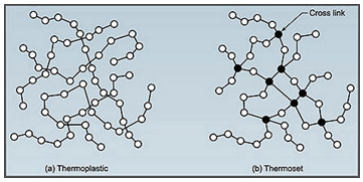
Polymer compound with nanomaterials for increasing mechanical stability and reducing products weight

Ramo Co.

New polymer compound with nanomaterial additives has better mechanical properties and lower weigh than previous products. These granules are produced in different polymeric matrixes.

Applications:
- Fabrication of car fan tray and under car tray
- Production of car bumper
- Manufacturing of products that are under mechanical forces

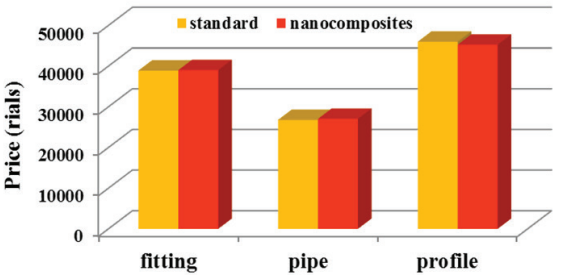
Exported to:
Afghanistan, Tajikistan, Turkmenistan, Kyrgyzstan.

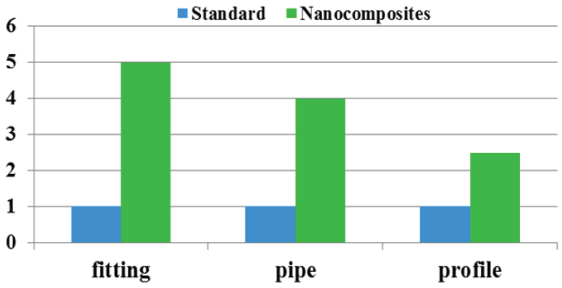


UPVC Nano additive for Improvement of Pipes, Fitting, Door and Window Profiles

Aria Polymer Pishgam Co.

UPVC is low price material with a good workability, suitable chemical resistance and proper thermal and mechanical properties. But The biggest problem in industrial production of Unplasticized PVC part including pipe, fitting and door and window profile is brittleness of these productions due to inherent characteristic of UPVC. So, UPVC manufactures are forced to use expensive impact modifier additives following high cost production. Aria Polymer Pishgam Company have been designed a special additive package containing nanoparticles and their carriers which are suitable for impact properties of UPVC parts.



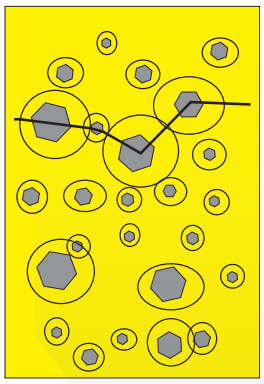


Advantages:

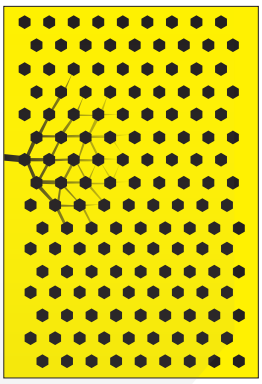
- High impact strength:
- Pipe: Improve up to 4 times in compared to standard;
- Fitting: Improve up to 12 times in compared to standard;
- Door and window profiles: Improve up to 2.5 times in compared to standards
- High vicat softening point; Cost reduction of final price;
- Decrease final price of products due to lowering of expensive additives.

Applications:
UPVC door and window profiles; UPVC pipes and fitting

Failure Mechanism

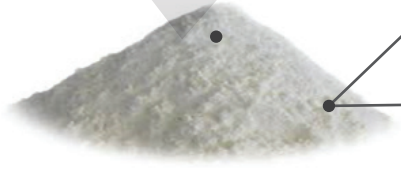


Toughening Mechanism



Mechanism for micro particle
- Concentrate stress
- Propagate cracks
- Brittle failure

Mechanism for nano particle
- Localized deformation
- Absorb energy
- Ductile failure



Anti-wear Elastomeric Nano Compound for Different Industrial Application

Fara pishtaz Hoonam Co.

FARARUB

The addition of nanoparticles to elastomer matrix creates many connection points in the particle-matrix interface. This product has improved the mechanical properties that it depends on good interface between matrix and filler.

Advantages:

- Increase in strength from 6.8 MPa to 10.8 MPa
- Reduction in weight loss from 20.36% to 10.36% in wear test
- Reduced elongation from 548% to 438%

Applications:

- *Manufacturing sealing washers and pipe fittings*

	Tensile strength (MPa)	Weight loss for wear test (%)
Typical sample	6.8	20.36
Nano sample	10.8	10.36

Anti-wear Nano Compound for Different Industrial Application

Mirco Co.

The addition of nanoparticles to matrix creates many connection points in the particle-matrix interface. This product has improved the mechanical properties that it depends on good interface between matrix and filler.

Advantages:

- Increase wear resistance
- High hardness
- Improve mechanical properties

Applications:

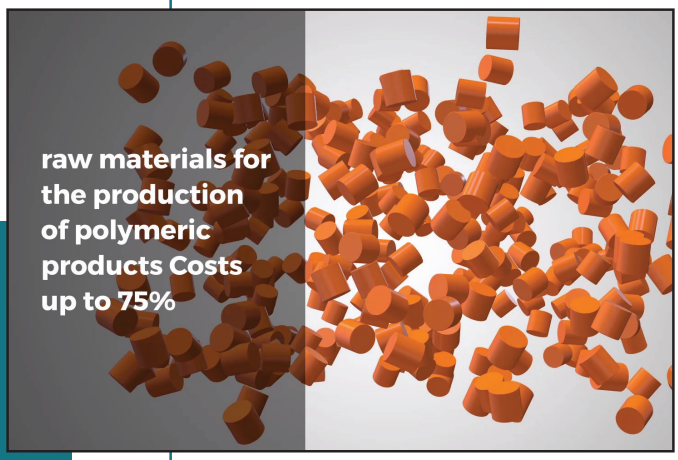
- *Coating for Bridle Rolls, Idle, Pinch, Squeeze, Loopcar and Pinger.*

	Typical sample	Nano sample
Density (kg/m^3)	1123	1116
The relative volume loss in abrasion test (mm^3)	149	123
Abrasion resistance index (%)	99.72	121.92

Thermoplastic Polymer Based Weight and Shrinkage Nano Compound for Various Industrial Plastic Parts

Plus Polymer Co.

The problem of distortion and shrinkage in thermoplastic polymers is one of the major problems in the various industries producing polymer parts. This product reduce weight and distortion in polymer parts.

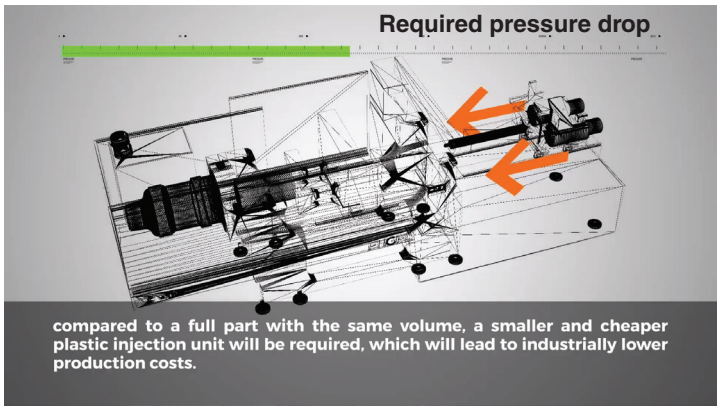


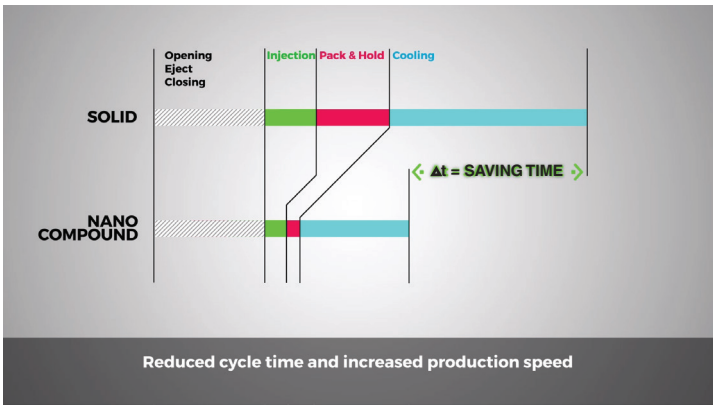
Advantages:

- Weight reduction of injection molding from 3% to 35% depending on final product characterization
- Increase of production rate by decreasing cooling time
- Lower costs and material consumption
- Highly improved dimensional precision of products
- Reduction or elimination of shrinkage and warpage of injection molding products
- Good mechanical properties
- Environmental friendly Technology (Green Tech.) by using lower plastic

Applications:

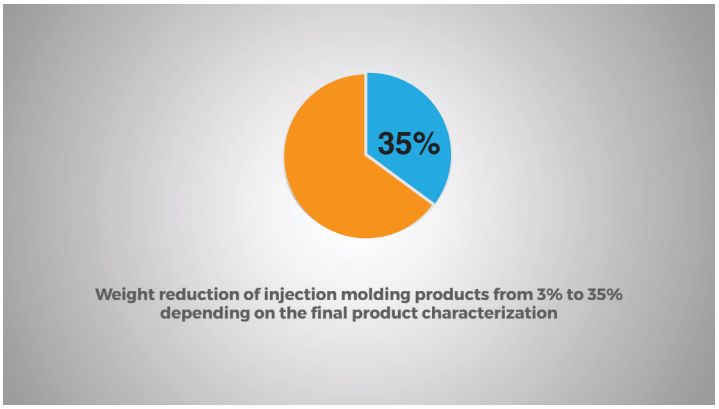
- *Automotive industry (bumper, frame of mirror and etc.)*
- *Plastic industry (pallet, chairs, waffles and etc.)*
- *Household appliance (washing machine, refrigerator, TV and etc.)*





ions of Plus 5 for waffle slabs

Properties	Raw	Plus 5 Nano Compound
The Melt Density (g/cm3)	0.963	0.879
Flexural Modulus (MPa) (ASTM D790)	645	1020
Impact resistance (J/m) (ASTM D256)	23.4	48.2
Impact Strength (MPa)	112	180
Melt flow index (MFI) (g/10min) (ASTM D1238)	18.04	26.13
Elongation at Break Load (%)	72	86



Nano Structure Corrosion Resistance Electrostatic Powder Coating for Painting For Various Industrial Application

Fam Gostar Mahan Co.
Rangin Nano Nahal Co.

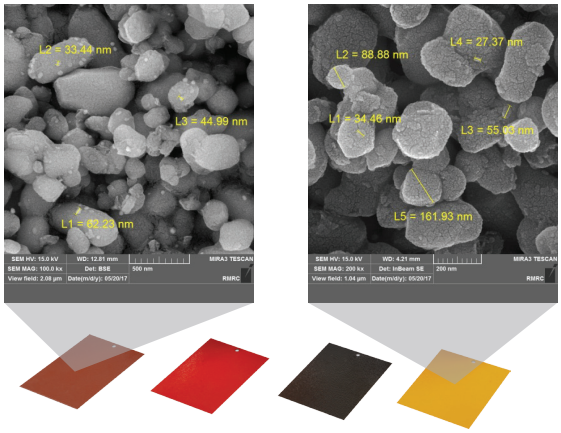
The corrosive weather factors reduce the quality of the coating on metal parts. The use of nanoparticles can improve the anti-corrosion properties of this coating.

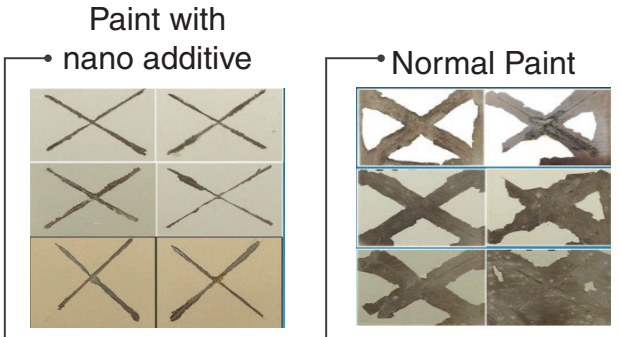
Advantages:

- Resistance to corrosion agents is up to 5 times higher than conventional coatings

Applications:

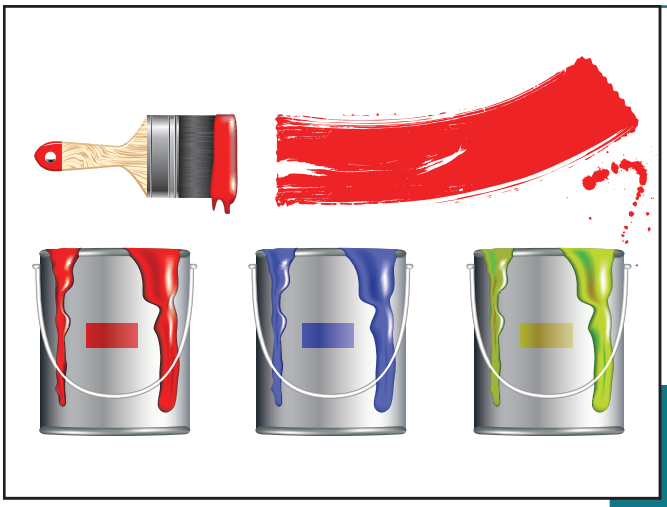
- *Interior auto parts, Kitchen appliances industry, Metal roofing ceilings, Iron doors and windows, Non-ferrous machinery and equipment, Cartridges and iron fences, Metal city furniture, Light bulb, Electrical panel and etc.*





The typical sample has started to blistering after 200 hours in the salt spray test, while the nanoscale sample is still not blistering after 1400 hours.

Periodic Survey Time (hrs)	Degree of Blistering	
	Typical Sample	Nano Sample
200	Few	No Blistering
600	Medium	No Blistering
1000	Dense	No Blistering
1400	Dense	No Blistering



Anti-Corrosion Nano Additive for Paints and Resins in Corrosive Environments

Nano Industrial Moean Innovators Co.

The nano additives have the ability to incorporate in the epoxy, different types of primer coatings, paints and resins. The percentage of the incorporated nano additive in epoxy-polyamide, paint or resin coatings can be 0.5, 1 or 1.5 wt % depending on the project.

Advantages:

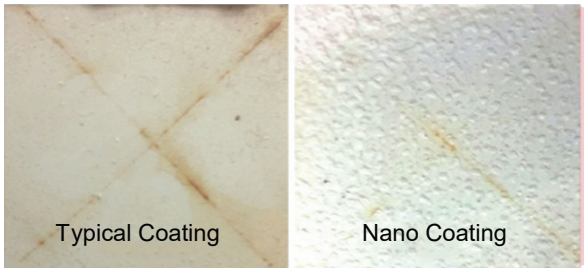
- Adding nano additive just to the under coating (primer coating) and it is not necessary to add it to the top coating.
- The consumption of nano additive is very small (<1.5 wt %).
- improving the corrosion properties of coating

Applications:

- *Automotive Industries, Marine Industries, shipyard docks and all metal in contact with the corrosive environment of 3.5% sodium chloride*

Increasing the electrochemical impedance improve the corrosion resistance. Also, the salt spray test has showed corrosion resistance up to 1100 hours compared to the typical one.

Product	Electrochemical impedance (kΩ)	Capacity (μF)
Typical Coating	27/9	$1/66 \times 10^{-2}$
Nano Coating	29200	$1/35 \times 10^{-3}$



Nano Structure Antibacterial Electrostatic Powder Coating for Painting For Various Industrial Application

Rangin Nano Nahal Co.

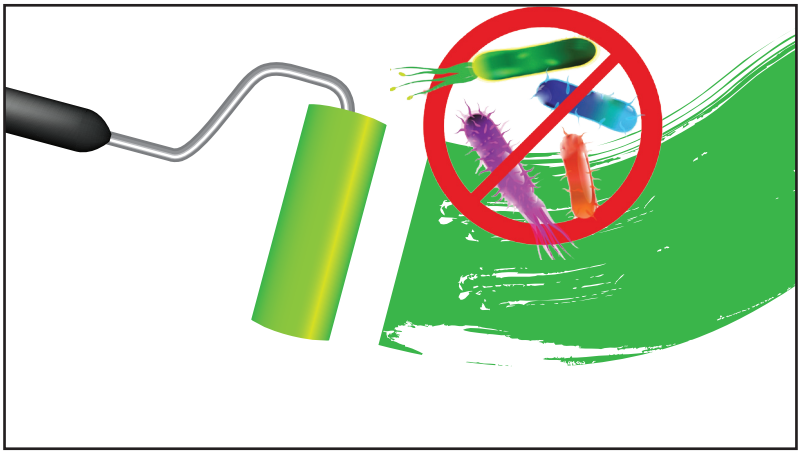
Nano structure antibacterial electrostatic powder coating is made of antibacterial nanoparticles that are capable of removing harmful bacteria on the surface of the coating.

Advantages:

- Elimination of E.coli and S.aureus bacterias up to 99.99%

Applications:

- *Auto Parts, Hospital equipment, hospital hoteling, beds and metal wardrobes, metal furniture, trolley and other similar equipment Units, operating room boxes, modular walls of the clean room, ventilation system, kitchen appliances, educational supplies and etc.*



Name of bacteria	E.Coli	Staphylococus aureus
Number of bacteria after 24 hours for typical samples	6×10^5	4×10^5
Number of bacteria after 24 hours for a nano sample	$1/2 \times 10^3$	$1/5 \times 10^3$
Concentration of bacteria in the initial suspension	$1/5 \times 10^5$	$1/5 \times 10^5$

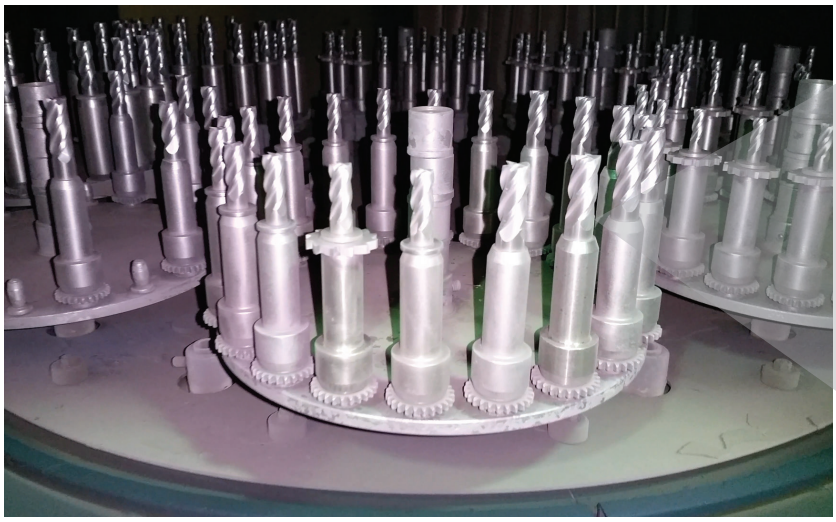
Hard Nanocoatings

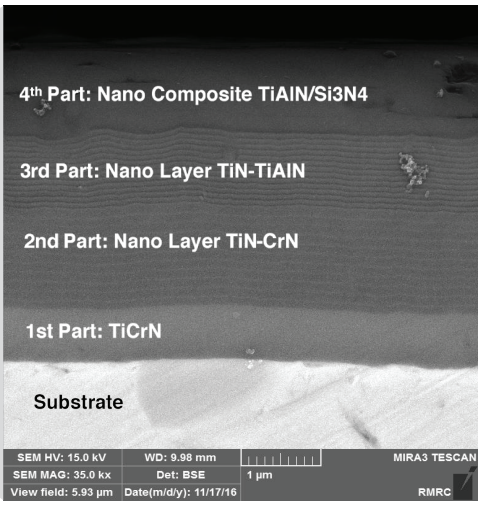
Sevin Plasma Co.

The activity of this company is based on design and development of PVD coating equipment to promote the coating quality and also design and deposition of new PVD coating. Achievement of this company is consist of three generation of hard coating as monoblock, multilayer and nanolayer & nanocomposite structure.

Advantages:

- Increasing the coating hardness up to 5000HV
- Increasing the toughness and impact ability of coating
- Improvement the roughness up to 0.1µm
- Decreasing the coating friction up to 0.05
- Increasing temperature resistance up to 1200°C
- Access to best wear and corrosion resistance





structure of Quad nano coating

Coating cycle:

		time	Description
1	Preparing parts before coating	-	Edge rounding , de greasing , polishing , micro blasting
2	Input parts to chamber	-	-
3	Vacuuming	2hrs	Achieve pressure≤10^{-5} mbar
4	Pre - heating	During vacuuming	Substrate temp: 250-450°C
5	Argon ion bombardment	10 min	-
6	Physical etching	20 min	High energy metal ions bombardment
7	coating	Rate:1 µm/hr	-
8	cooling	30 min	Final temp≤200°C

Machine Description

No	Part
1	Process chamber
2	Vacuum pumps
3	Plasma source
4	Gas line
5	Heating & Cooling
6	Vacuum gauge
7	Process control
8	target

Hard Nanocoatings

Sevin Plasma Co.

PVD hard coating is one of the best methods for coating hard nano-structure films and optimising the hardness to residual compressive stress ratio. Finally we have a film of hard refractory material 2-7 microns thick. For the hard coating, we are currently able to provide TiN, TiC, TiCN, AlTiN or TiAlN, CrN, AlCrN ,CrAlTiN , TiAlSiN, CrAlSiN, DLC coating.

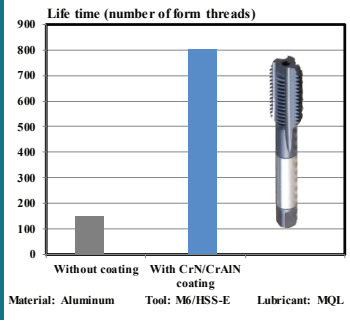
Applications:
Tools and Dies, Automotive, Oil &Gas, Aerospace, Metallurgy and another industries

Coating specifications

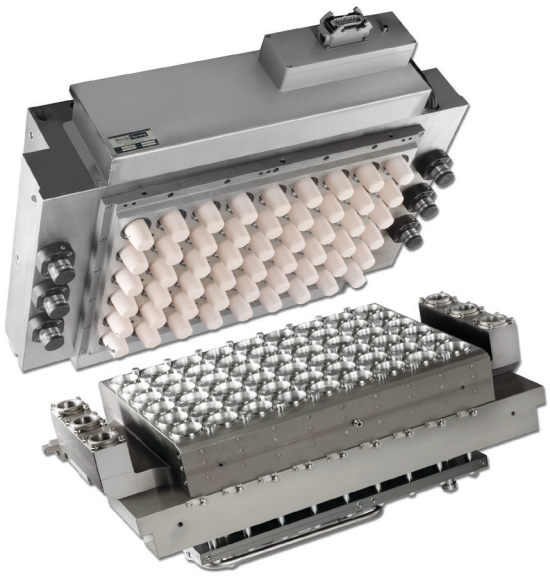
No	Coating	Regular Thickness (µm)	Hardness (HV)	Roughness(R_a) (with no polishing)	Color
1	TiN	2-6	2500	<0.4	Gold
2	CrN	2-4	2200	<0.2	Silver
3	TiN-ZrN TiN-CrN CrN-ZrN	2-8	3000-4000	0.2-0.4	Gold Silver Light gold
4	TiN-TiCN TiN-TiAlN TiN-TiCN-TiAlN TiN-TiCN-TiAlN-TiAlCN	2-8	3000-4000	0.2-0.4	Depend on top layer
5	CrN-CrCN CrN-CrAlN	2-8	3000-4000	0.3-0.7	Silver Gray
6	Triple coating option “A”	2-8	3000-5000	0.1-0.5	Depend on top layer
7	Quad coating option “A”	2-8	3000-5000	0.1-0.5	Depend on top layer

Tapping

Aluminum tapping – Production of auto engine

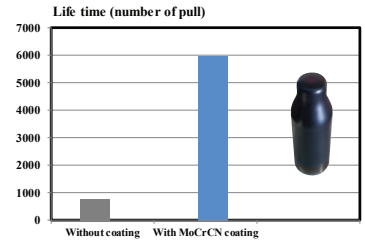


Material: Aluminum Tool: M6/HSS-E Lubricant: MQL



Deep drawing dies

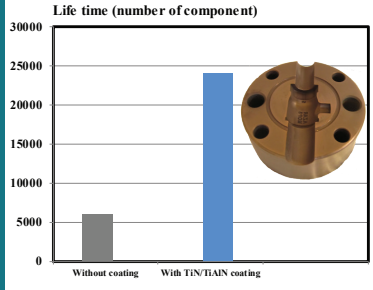
Steel deep drawing-Auto component production



Material: 316 St.St. Mold: SPK cold working with 58HRC hardness

Mold

Brass hot forging - production of gas valve

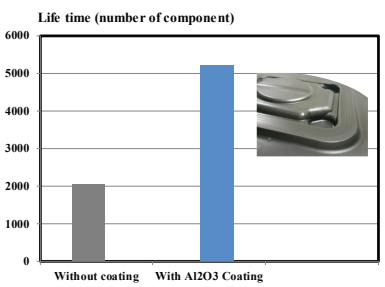


Material: CuZn39Pb2 brass Temp.: 700tC

Mold material: H13 hot working mold with 48HRC hardness

Mold

Steel hot forging – Production of auto component



Material: CK45 Temp.: 1100tC Load: 1600 ton

Mold material: H13 hot working mold with 48HRC hardness

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Industrial and Marketing
Department of INIC

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