SAND2009-7372C

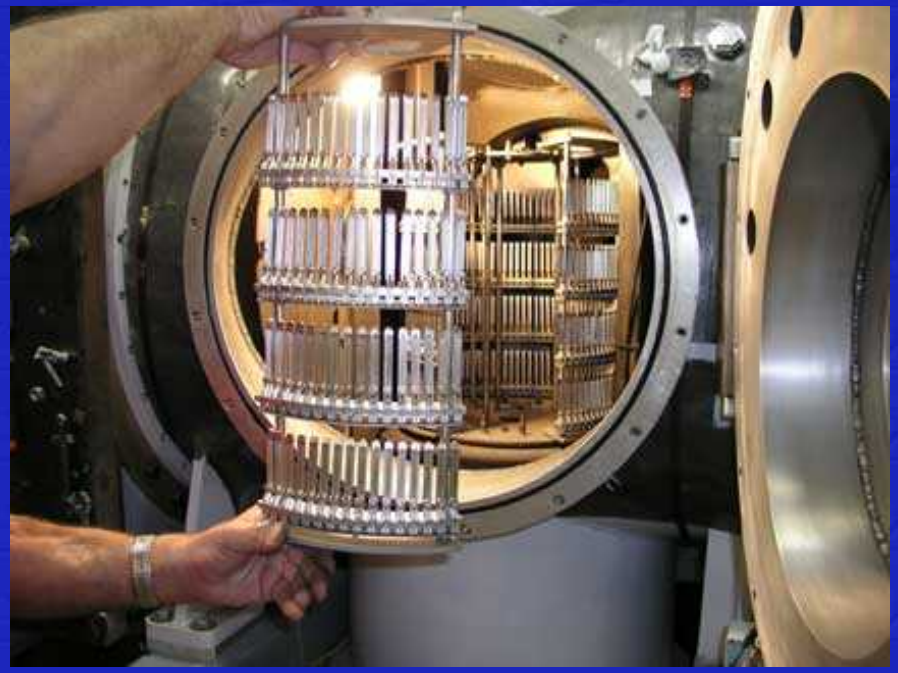
A Great Option You Didn't Know You Had

An Alternative for Electroplating and Much More

ALPHA-OMEGA Power-Technologies LIMITED COMPANY

Ion Beam Surface Treatment (IBEST)

- Technology
- Applications
- Comparisons
- ROI
- Q & A



What IBEST is NOT

Ion Implantation

Physical Vapor Deposition

Plasma Enhanced – Chemical Vapor Deposition

Conventional Sputtering

Cathodic Arc

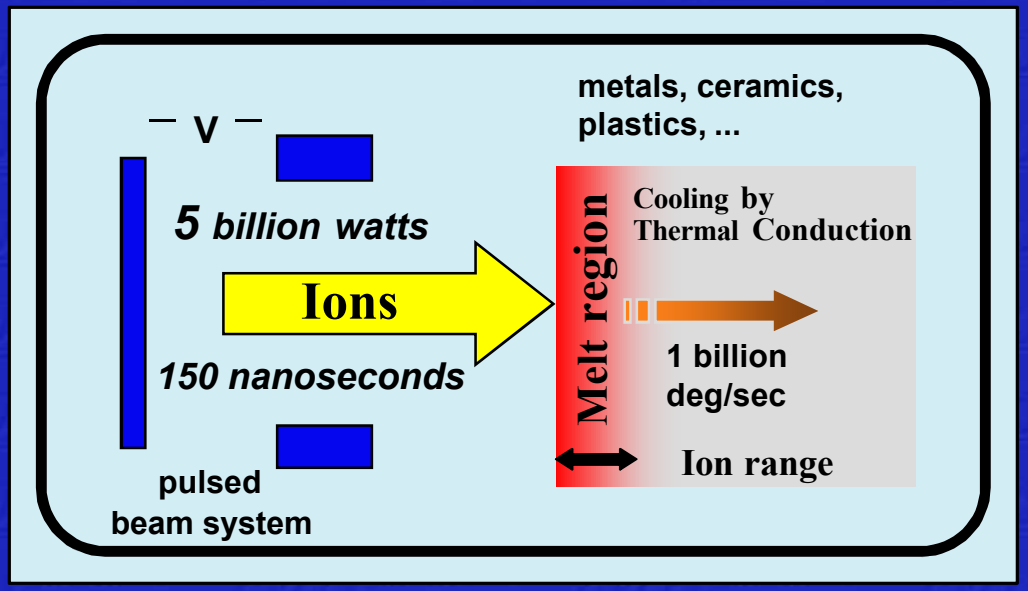
Spray Plasma

Pulsed Laser Deposition

Etc.

Ion Beam Surface Treatment (IBEST™) Technology

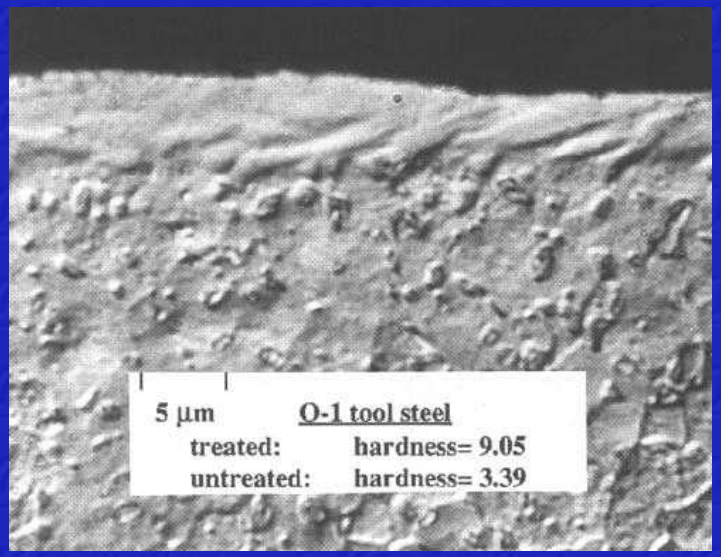
- Thermal process
- High Power Ion Beam
- Rapidly pulsed
- Hitting target in vacuum
- Ions penetrate any target
- Depth 5-20um
- Effects 100-200 um



Ion Beam Surface Treatment (IBEST™) Technology

- **Rapid Melt and Resolidification**
- **Substrate acting as a heat sink**
- **Cools melted surface layer <1us**
- **Improve surface properties**

- **Alloy or anneal thin film depositions**
- **Removes unwanted coatings**



Methods of using IBEST

Direct Beam Surface Modifications	Direct Ion Beam treatment creates structure change without composition change
Alloying Pretreated Surface	A thin film layer is deposited on a substrate by conventional means followed by the ion beam melting the layer and some of the substrate which undergoes mixing by liquid phase diffusion
Concurrent Ion Beam/ Sputter Deposition	Ion beam induced plasma (ablation plasma) radiates from the target surface, touches an opposing solid surface, cooling the plasma, leaving a thin film of the target material
Pretreat for Secondary Surface Treatment	Direct Ion Beam treatment followed by secondary surface treatment to improve performance of secondary treatment
Surface Coating Ablation	Ion Beam removes coating materials to expose substrate

Benefits of IBEST™ Technology

Provides Longer Life and Improved Performance

- Hardening
- Smoothing / Lubricity
- Corrosion Resistance
- Improved Surface Integrity / Strength

Improved Surfaces Without Dimensional Change

- Homogeneous, Ultra-fine Grain Surfaces
- Better Wear, Corrosion, and Fatigue Resistance

Enhanced Appearance

- Smooth, Fine Grain Surfaces

Alloying and Annealing

Improved Bonding and Surface Cleaning

Benefits of IBEST™ Technology

Ecologically Friendly

Process releases no effluents, is chemical-free, produces no waste stream, and uses negligible consumable materials; a "green" technology.

Cost Effective

The short processing time, and single step operation makes it less expensive compared to some other, much slower, multiple step surface treatment techniques.

Demonstrated Benefits of IBEST

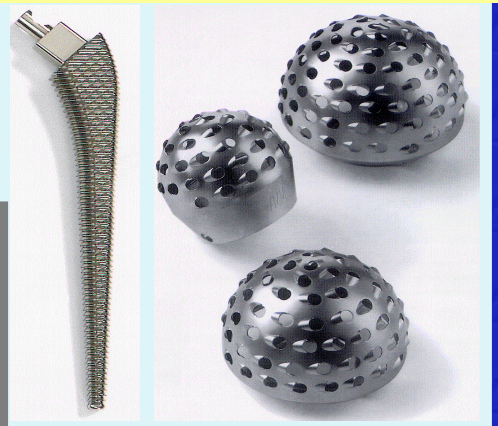
IBEST™ surfaces :

- Can be smoother, harder, resistant to wear, corrosion, and fatigue
- Preserves precision dimensions to better than **1/10,000 inch**
- Last longer and perform better in critical applications.

BioCompatible

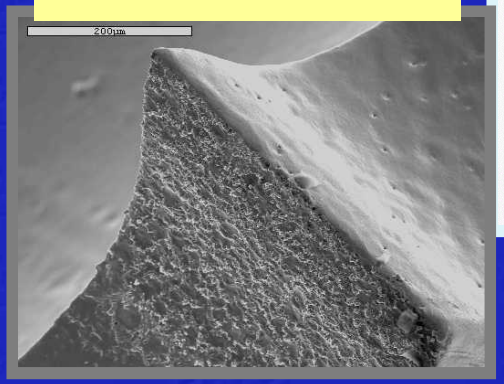
Tools & Dies

Medical Instruments

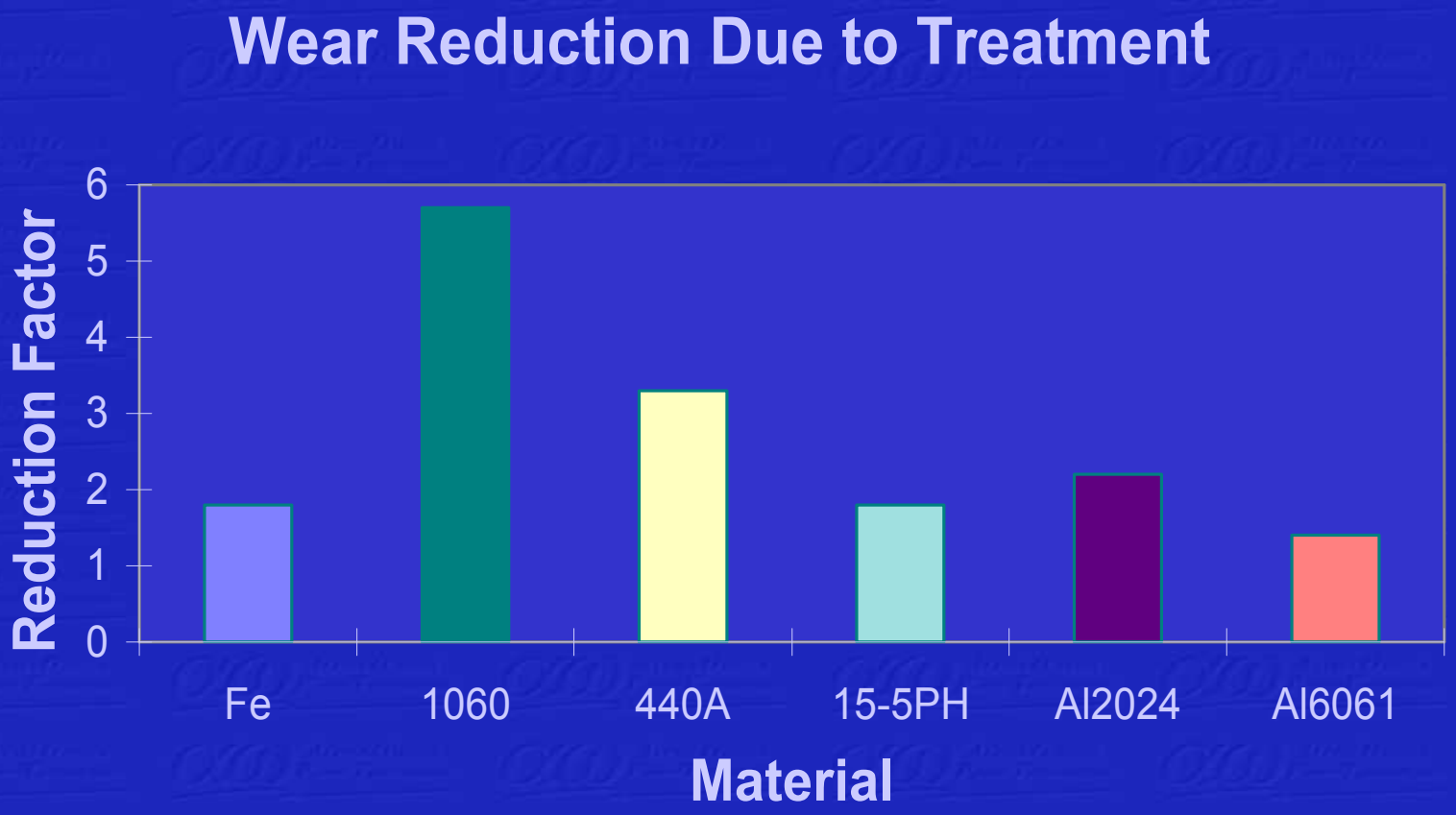


Gears and Bearings

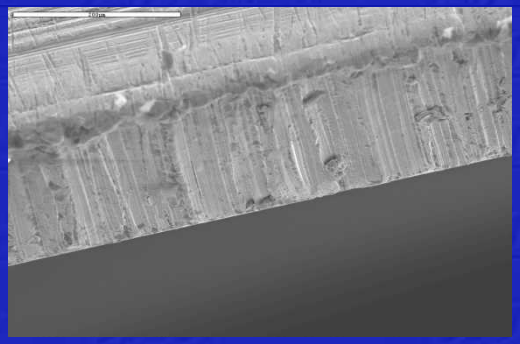
Precision Parts



Results Of Rapid Melt and Re-solidification Show Reduced Wear

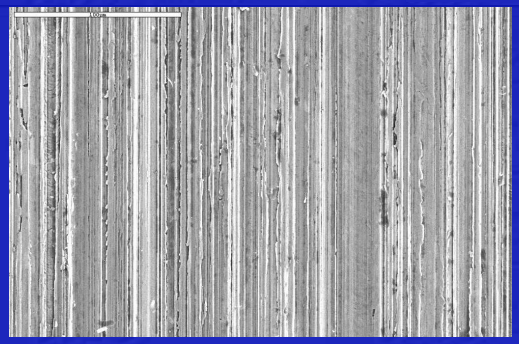


IBEST™ Applications



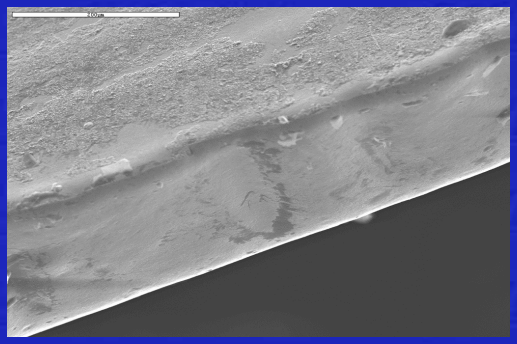
250X Untreated Cutting Blades

Blade edge with typical machine marks



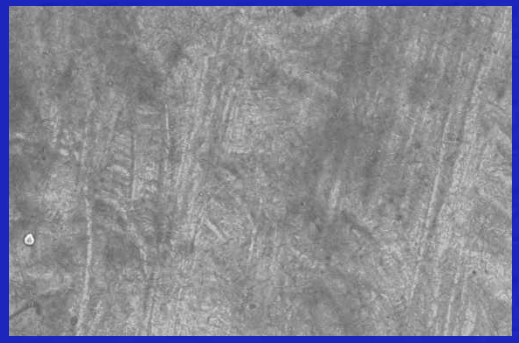
500X Untreated Cutting Blades

Machining mark details



250X Treated Cutting Blades

Treatment with IBEST smoothes features and removes machining marks



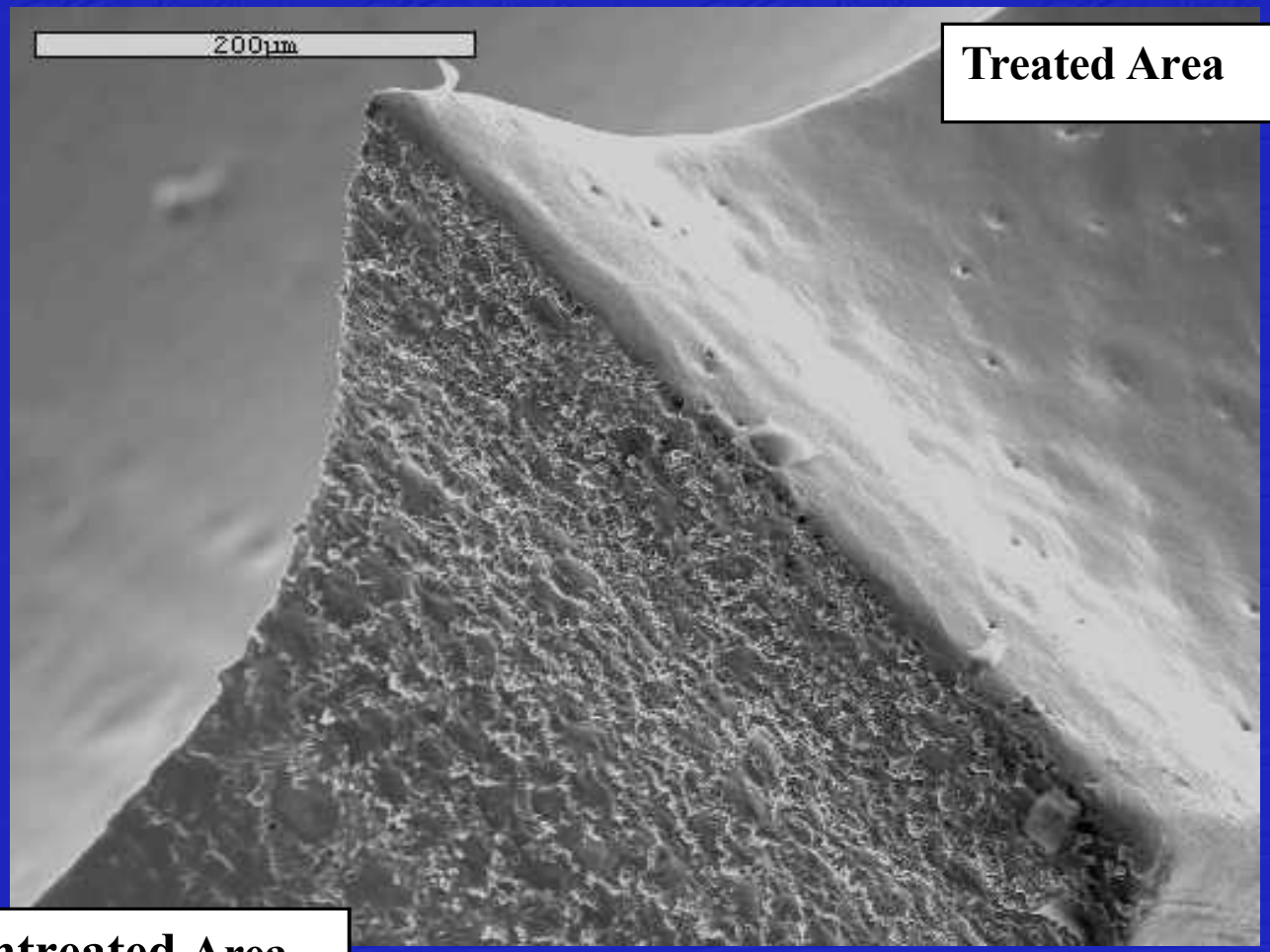
500X Treated Cutting Blades

Details of smoothing.

Lifetime Extension of Carbide and High Alloy Steel Tools

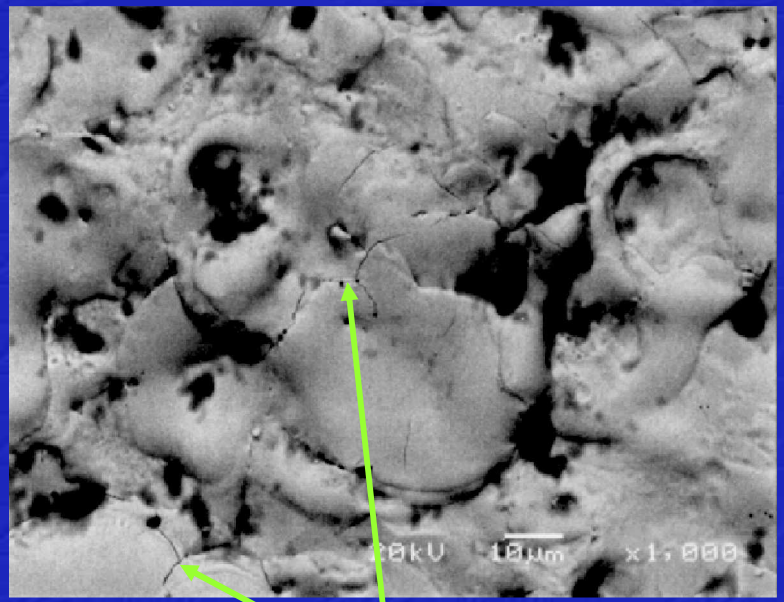
Tests have demonstrated significant lifetime extension of tools cutting aluminum and cast iron made harder and smoother with IBEST.

IBEST Improves the Surfaces of Precision Electric Discharge Machined Parts



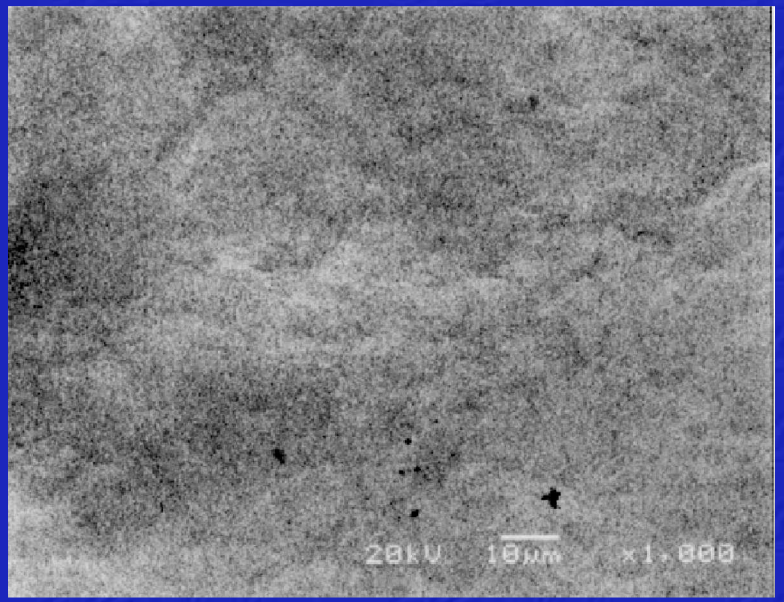
Wire EDM Cut Tool Steel Surface

BACKSCATTER ELECTRON MICROGRAPHS
Magnification = 1000x



Cracks in EDM Processed Surface

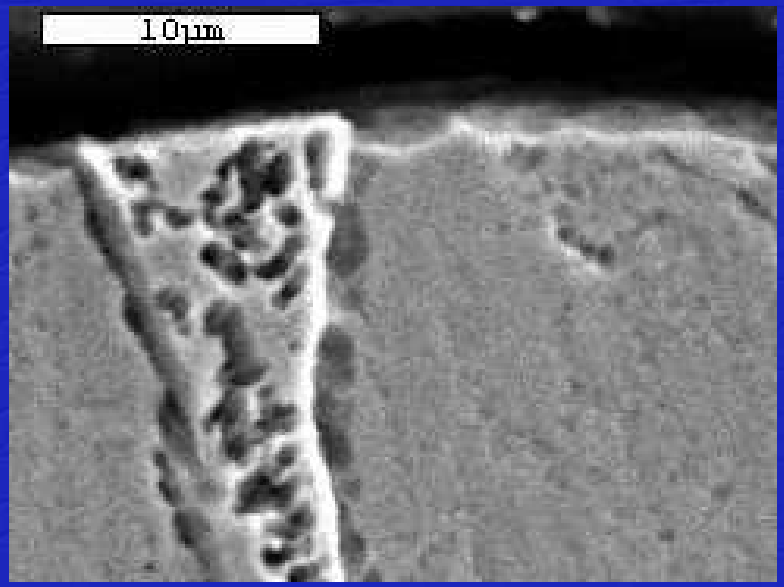
Untreated Part



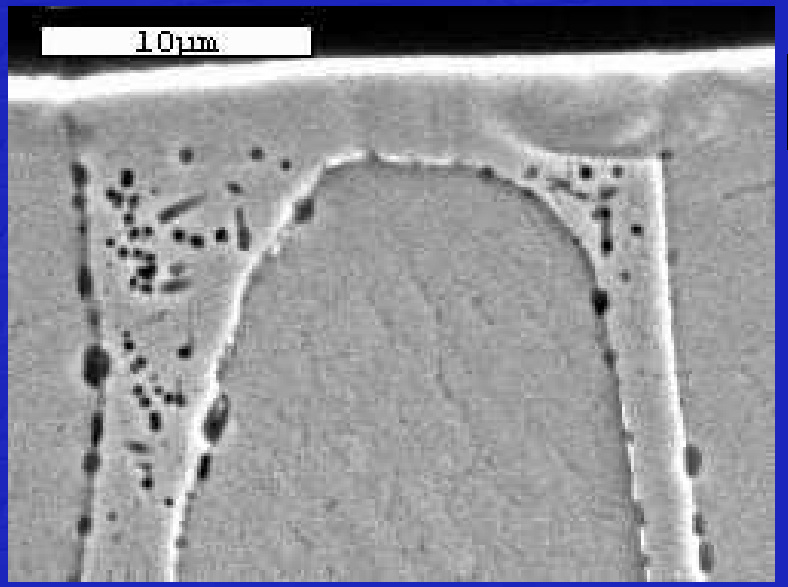
IBEST Treated Part

- Cracks and Other Defects Removed

IBEST™ CLOSES PORES AND SEALS SURFACE OF MIM PARTS



BEFORE IBEST
17-4 PH STAINLESS STEEL

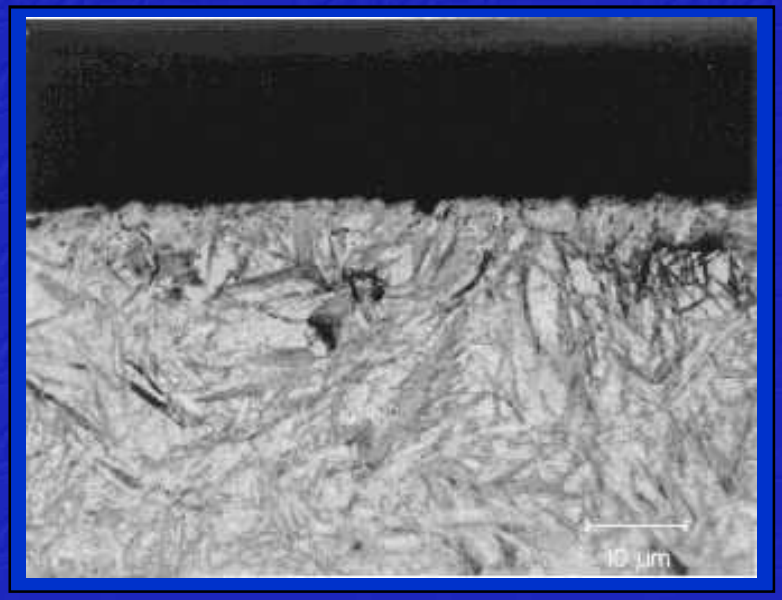


AFTER IBEST
17-4 PH STAINLESS STEEL

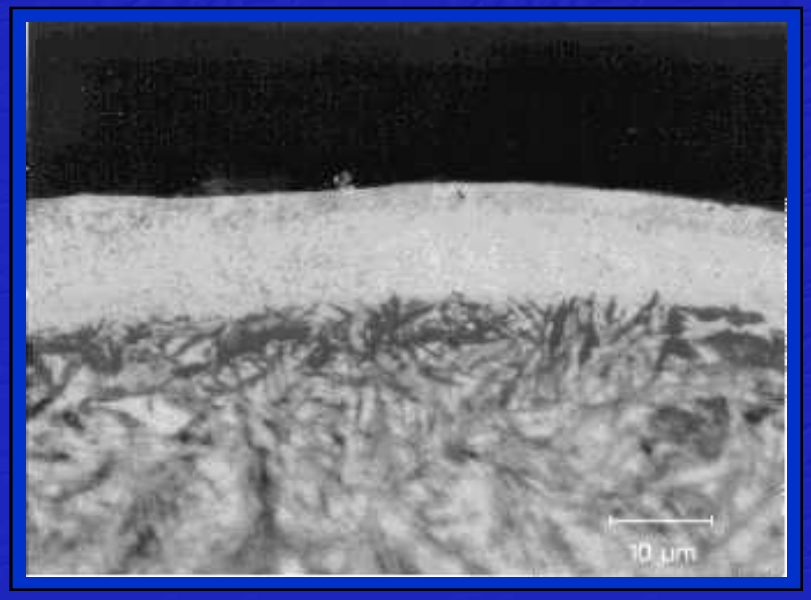
IBEST Can Seal Metal Surfaces

Healing of Surface Cracks

Tests of gear material for a leading automotive supplier eliminate surface cracks in carburized materials to a depth of approximately 10 microns.



Untreated (1500X)



Treated (1500X)

Carburized 8822 Gear Steel

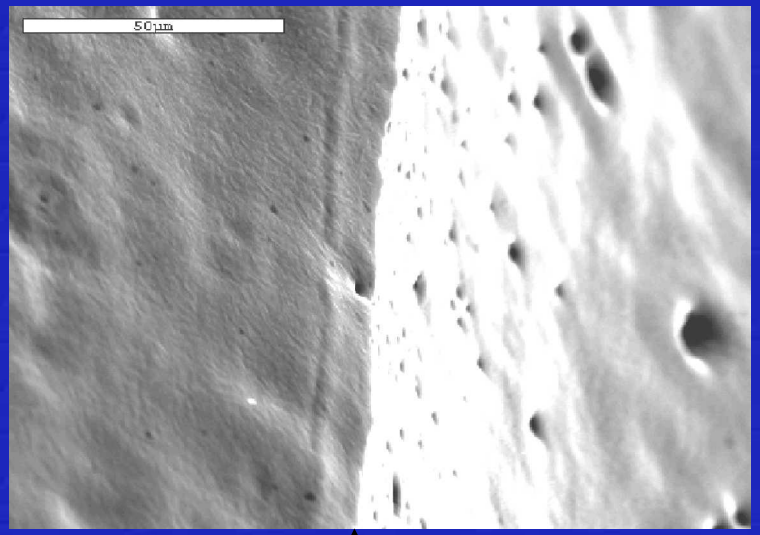
Rolling contact and bending fatigue :
10-100 times longer fatigue life with 30% lower sliding wear.

IBEST Improves Flexible Rotary Die Surfaces

Before

Cutting Edge

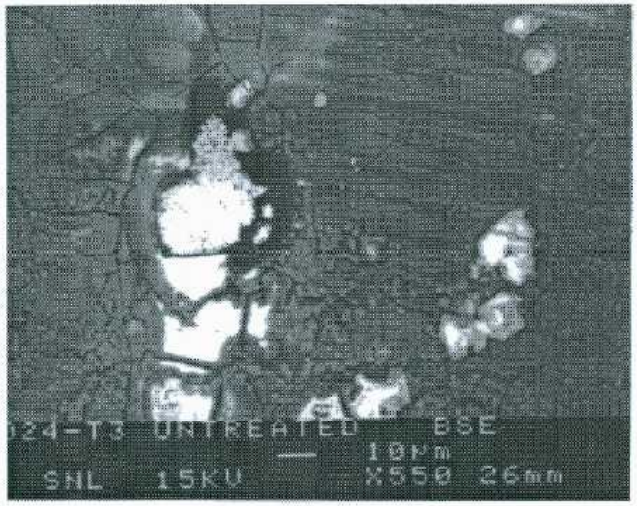
After IBEST



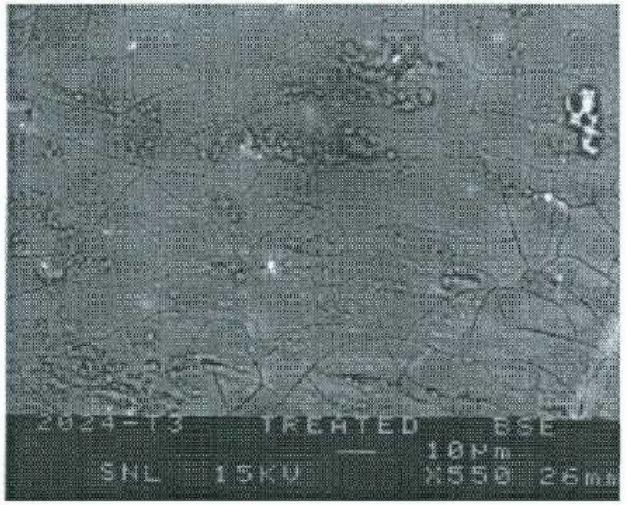
Cutting Edge Retained
Smoothed, Sealed, Deburred

Treated dies last 2-10 times longer and cut cleaner.
Materials : 420 tool steel and 1075 carbon steel.

Salt Fog Exposure Tests Show Corrosion Resistance of IBEST-Treated Al 2024-T3



Untreated Sample area shows pitting in 168 hour exposure



The treated area shows no pitting. Treatment intensity: 2-3 J/cm^2

Anodic Polarization tests also confirm these results

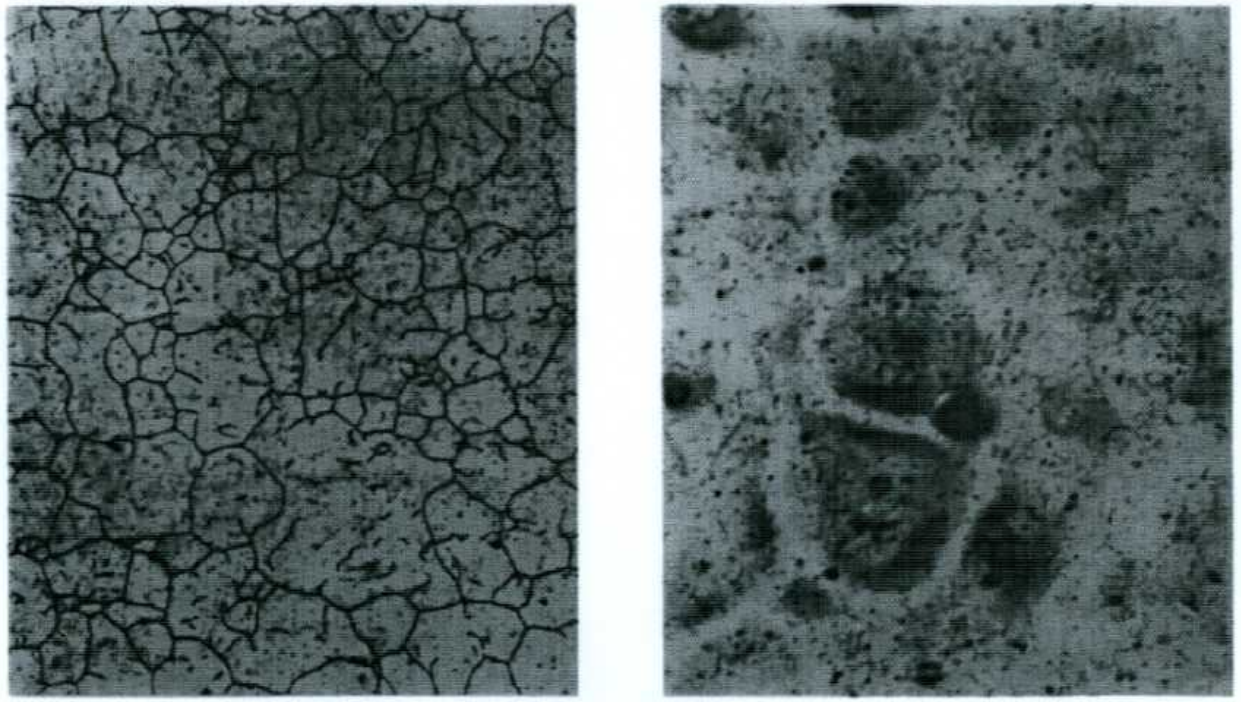
Corrosion resistance without solvents or heavy metals is possible using IBEST

Materials Modification Laboratory

Sandia National Laboratories

Sandia National Laboratories

IBEST can eliminate corrosion at grain boundaries in welds



304 stainless steel sensitized for 100 hr at 600°C, subjected to 0.5M H_2SO_4 + 0.01M KSCN

Corrosion and Fatigue Resistance

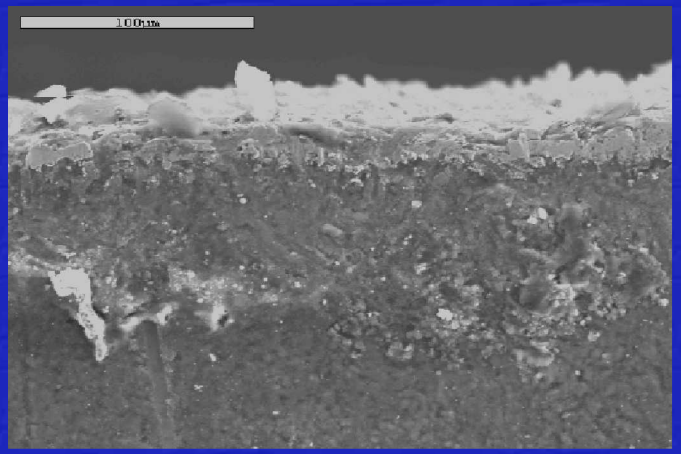
Turbine manufacturer tested, uncoated, 17-4PH stainless steel, forged turbine blades showed no corrosion in 1000 hour salt spray test. Tests using titanium alloy compressor blades demonstrated significantly increased fatigue and erosion resistance.

IBEST™ REMOVES BURS AND DEBRIS FROM EDM SURFACES

ALPHA-OMEGA Power-Technologies LIMITED COMPANY

Untreated Sample
Rough-Burrs

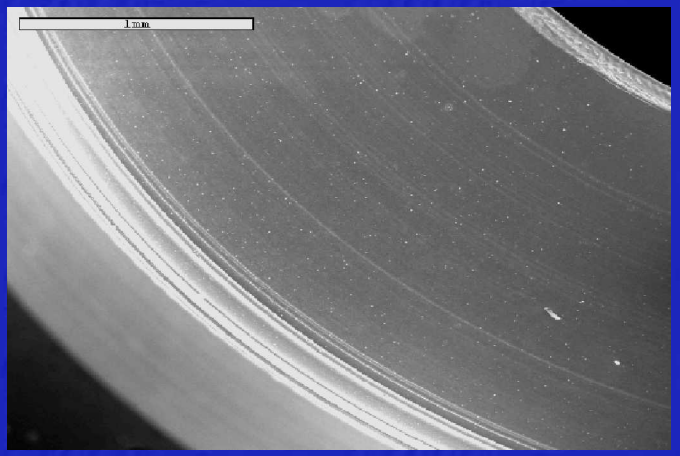
Countersunk Hole

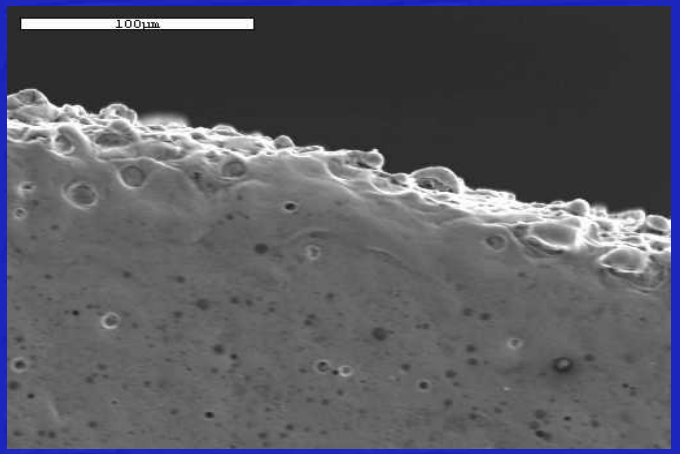


Edge

IBEST

IBEST Treated Sample
Smooth-Burrs Removed



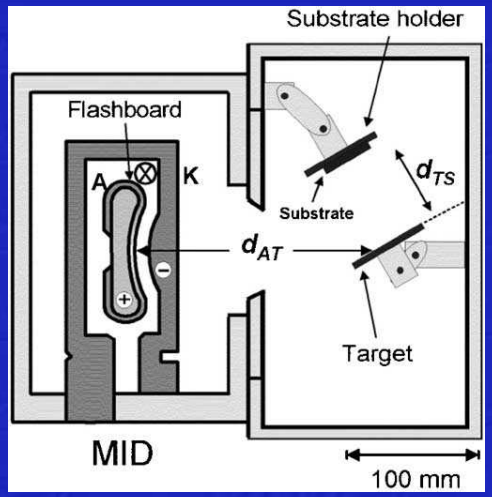


A Growing List of IBEST Applications

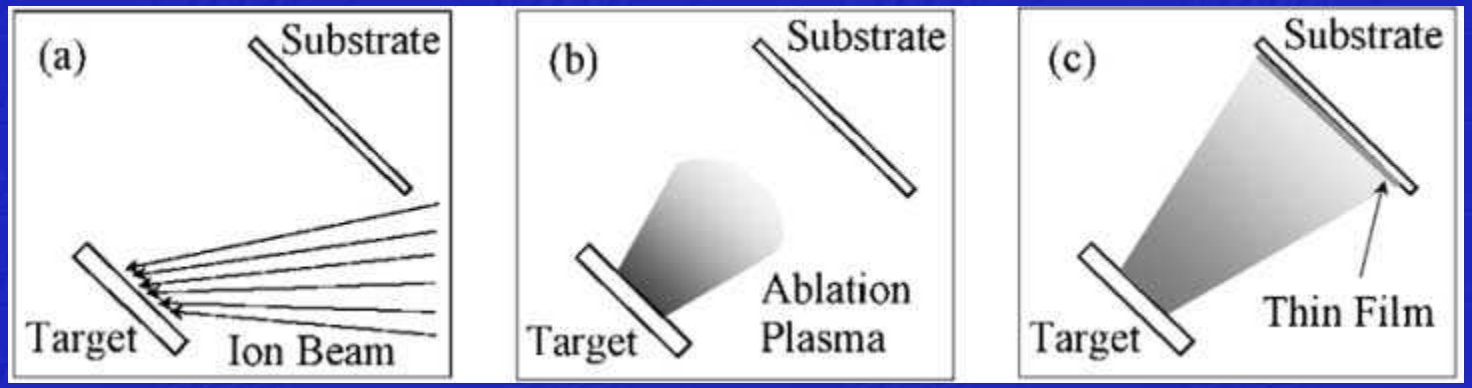
Material	Demonstrated Benefit
All metals	creation of fine grain (<150 nm) crystal structure
1045 and 1060 carbon steel	hardness, smoothness, homogeneity, wear
304, 316, stainless steels	improved corrosion resistance
15-5PH, CRES 320	improved corrosion resistance
17-4-PH stainless steel	corrosion resistance, hardness, smoothness
440A, 440C martensitic steel	improved wear, lubricity, and hardness
8620 gear steel	crack healing, homogenization
M2 tool steel	hardening, smoothing
M7 and M42 tool steel	smoothing, homogenization
O-1 tool steel	hardening, wear resistance
H13 tool steel	hardening, wear resistance
80%Fe-20%B	smoothing, amorphous structure
Ti-6-4	smoothing, fatigue and erosion resistance
Al 2024, 6061	corrosion resistance and wear
Cemented tungsten carbide	smoothing, and wear resistance
Powder metallurgy parts	smoothing, surface sealing, hardening
Polycarbonate	improved adhesion

Concurrent Ion Beam / Sputter Deposition

Ion beam induced plasma (ablation plasma) that radiates perpendicular from the target surface, touches an opposing solid surface, cooling the plasma, leaving a thin film on it.

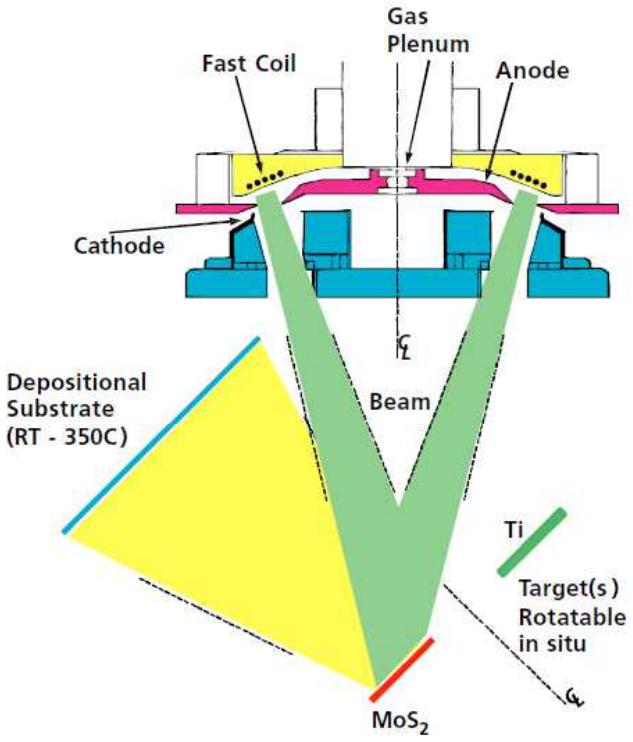


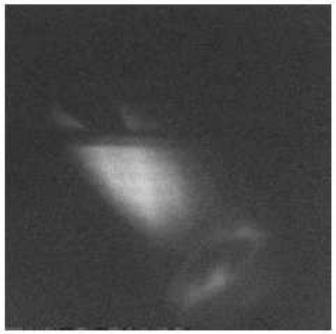
Setup of thin-film deposition by IBE.



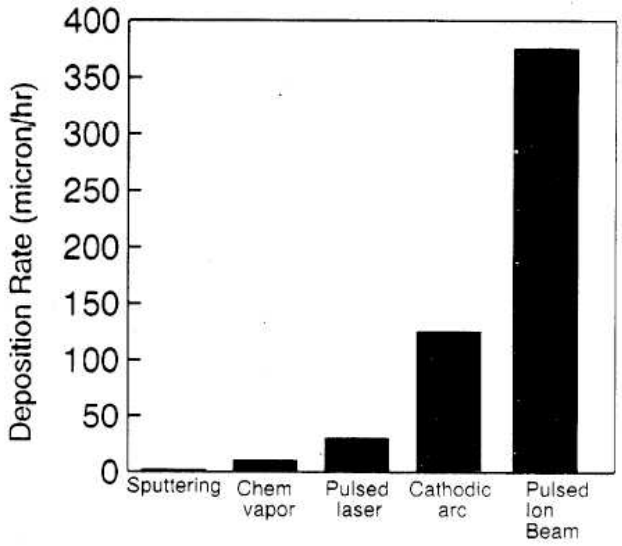
Basic processes of IBE. (a) Ablation plasma generation by pulsed ion beam. (b) Ablation plasma expansion toward the substrate. (c) Thin-film deposition on the substrate surface.

Pulsed Ion Beams can achieve high deposition rates of novel material films





- In Sandia experiments, an intense nitrogen beam is used to ablate target(s). (Left) Alternating MoS_2 and Ti targets are rotated into target position for beam ablation.
- Process resembles Pulsed Laser Deposition, but 30 cm^2 ablation spot size on target increases deposition per pulse by up to 2 orders of magnitude (below right)
- Nitrogen beam forms ablation plume normal to target surface. Distance target-substrate ~ 35 cm. (Below left) Framing image of plume leaving target.
- Film thickness/pulse from 10 to 5000 Å



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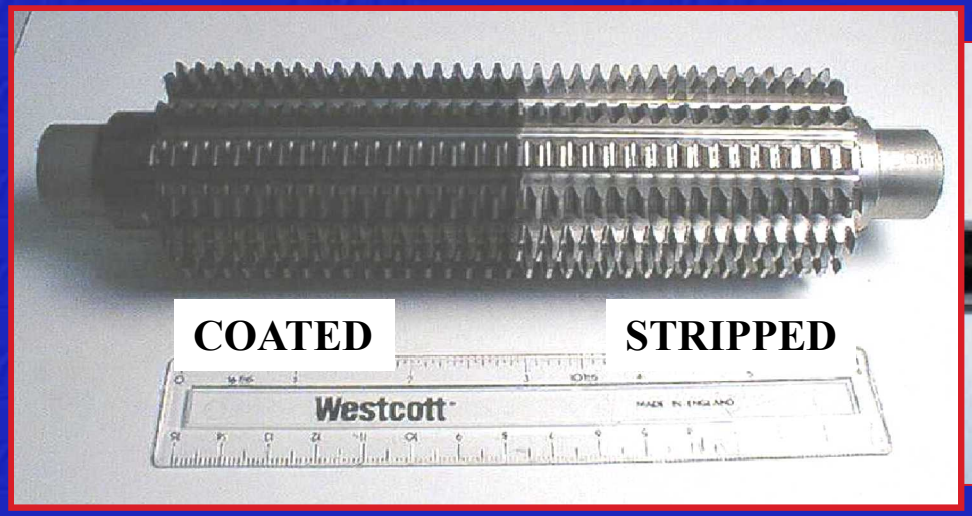
Sandia National Laboratories

IBEST Rapidly Strips Coatings Using a Chemical-Free Process That Does Not Damage the Surface



Surface Preparation for Coatings

Ability to prepare surfaces for subsequent coatings by cleaning, melting, and homogenizing surfaces while removing inclusions, cracks, or other defects that could lead to coating failure.

IBEST™ has shown that it can remove unwanted coatings or surface layers while preserving precise dimensions of the underlying material.

IBEST ROI - Price vs. Cost

Price for IBEST Treatment varies depending on:

- Size & shape of treated component
- Material & process formula
- Service location, shipping & handling

Return on Investment includes:

- Extended life reduces replacement parts
- Cost to repair or replace
- Downtime of product
- Pain & Suffering (Medical Implants)
- Environmental Impact
- Marketing benefits

IBEST Summary

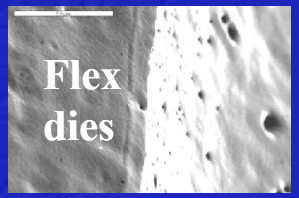
A new technology in terms of wide scale commercial application
With demonstrated benefits for numerous products

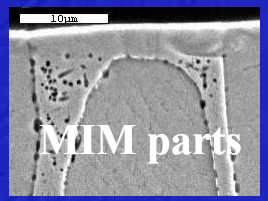
250X Treated Cutting Blades

Provides Longer Life and Improved Performance

- Produces improved surfaces without dimensional change by melt and resolidification in less than a millionth of a second
- Better wear, fatigue, corrosion, and lubricity
- Homogeneous, ultra-fine grain surfaces
- Surface cleaning and preparation without chemicals
- Aesthetics / Cosmetic enhancement
- Bio Compatible for medical applications

COST EFFECTIVE … at high throughput rates, with no consumables or waste





A Great Option You Now Know About

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