

## Surface Treatment of Implants- A Review

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### Surface Treatment

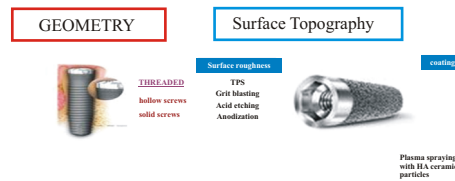
An implant is textured to make it suitable for enhancing;

- Bone Implant Contact (BIC) or
- Induce Osseointegration

### Aim

- Enhance Cellular Activity
- Enhance Cellular Activity

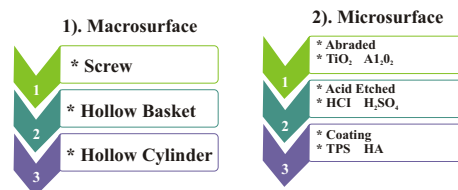
### Conventionally Employed Implant



### Design

- Geometry – Initial Stability
- Topography – Later Biological Changes

### Types of Surface Roughness



- Increased Surface Area
- Optimized Biologic Response
- Micromechanical Interlocking
- Direct Correlation in Roughness & Cellular Activity
- Parallel Orientation- Capsule Like Bone Adaptation
- Perpendicular Orientation
- Real Bone Fiber Osseointegration

### Sandblasted & Acid Etched (SLA) (Straumann)

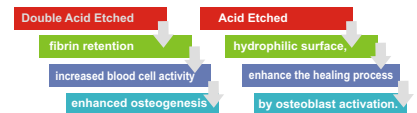
- Large Grit (250 To 500  $\mu\text{m}$ )
- Etching with Hydrochloric/Sulfuric Acid.
- Decreased Contact Angle By  $10^\circ$  - Better Cell Attachment.
- Increase in Osseointegration

- By Removal of Alumina Particles (Cleaning).



Sand blasting - surface roughness  
Acid etching- cleaning

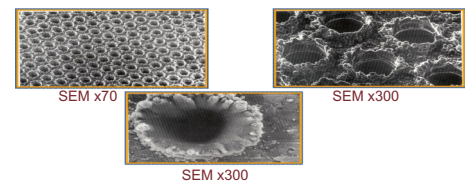
Wennerberg et al. 1996: superior bone fixation and bone adaptation



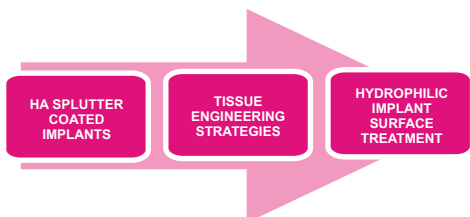
### Laser Induced Surface Roughening

“Used to create roughness”

Regularly oriented surface roughness configuration compared to TPS coating and sandblasting



### Some Advances In Surface Topography....



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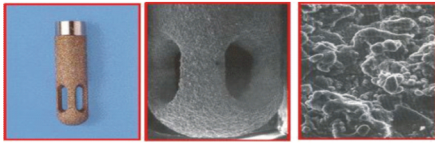
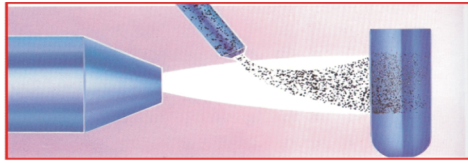
Website:  
[www.healtalk.in](http://www.healtalk.in)

DOI:  
[10.4880/zenodo.5296357](https://doi.org/10.4880/zenodo.5296357)

Quick Response Code:



### Titanium Plasma Sprayed Coating (TPS)

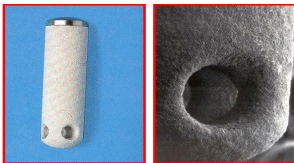


Steinemann(1988)  
Tetsch(1991)  
6-10 times increase in surface area.

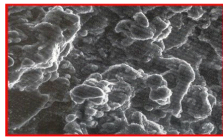
Merits	Demerits
Increased ionic interactions	Cracking and scaling of coating
Increased load bearing capability by 25%-30%	Accumulation of abraded material in the interface Zone.
Increased Tensile Strength	

### Hydroxyapatite Coatings

Hydroxyapatite  $[Ca_{10}(PO_4)_6(OH)_2]$  coating was brought to the dental profession by Degroot



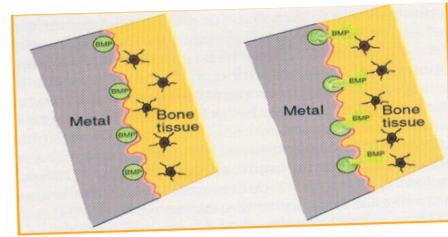
HA coated implant - bioactive surface structure- more rapid osseous healing  
Increased initial stability



Indication:  
- Fresh extraction sites.  
- Newly grafted sites.

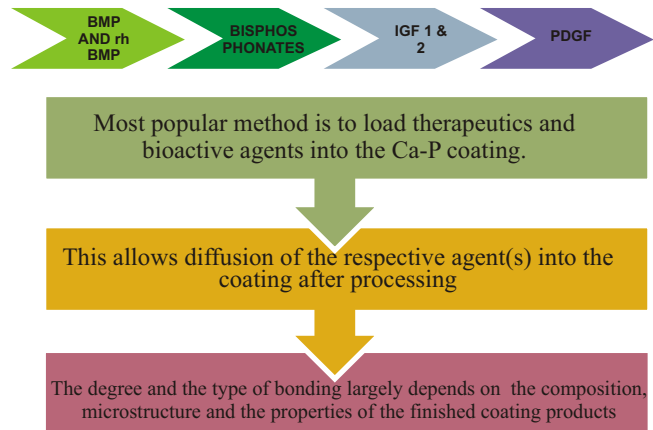
Merits	Demerits
Protection of surrounding bone against metal ion release from the substrate	Induction of impurities due to thermal decomposition during processing- affecting long term clinical fixation
Reported chemical bonding between HA and living bone-intimate contact-biointegration	Dissolution of HA at lower pH.
Partial dissolution of HA makes surrounding fluid rich in calcium & phosphate ions which trigger cellular differentiation & bone formation	

### Doped Surfaces

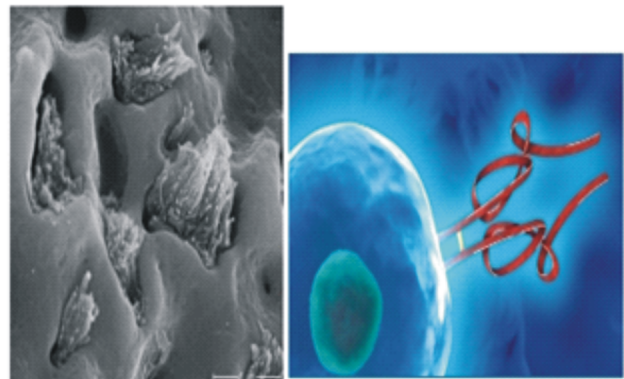


Doped surfaces various types of **bone growth factors** or other **bone-stimulation agents**  
\* Advantageous in compromised bone beds.  
\* Clinical documentation of the efficacy of such surfaces is lacking.

### This Development Has Made It Possible To Incorporate Therapeutic Agents Directly Into Ca-P Coating.



Experimental investigations with a BMP known as recombinant human BMP-2 (rhBMP-2) in animal models have shown that it promotes initial integration of dental implants and “rescues” implants affected by experimentally induced peri-implant bone loss.

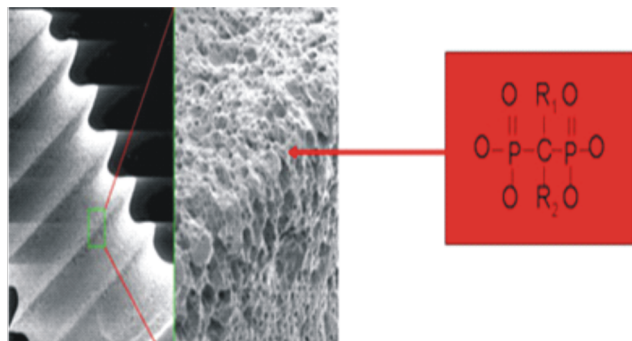


### Hydrophilic Implant Surface Treatment

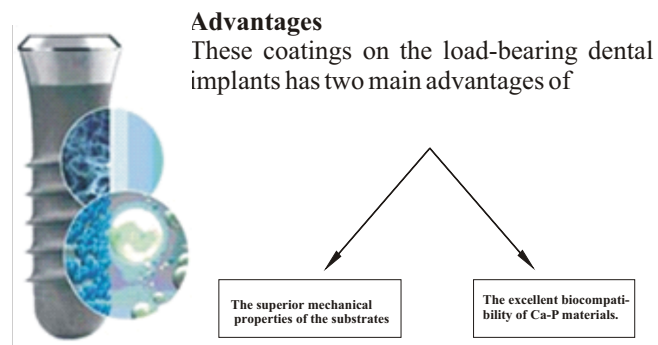
These exhibit a fundamentally improved surface chemistry.

- These implants are initially
- Sandblasted With Large Grit
  - Acid Etching
  - Conditioned
- } Achieve an optimal topography
- Immediately preserved in an isotonic saline solution. (helps maintain a high surface activity, which would otherwise be lost due to reaction with the atmosphere.)

Coating with pharmacological agents such as BIPHOSPHONATES may be a way of locally improving bone density in highly cancellous bone.



Due to this ideal conditioning, the implant surface quickly attracts blood and proteins, potentially promoting the process of bone formation and thus increased early stability.



### Laser-Lok® Microchannels

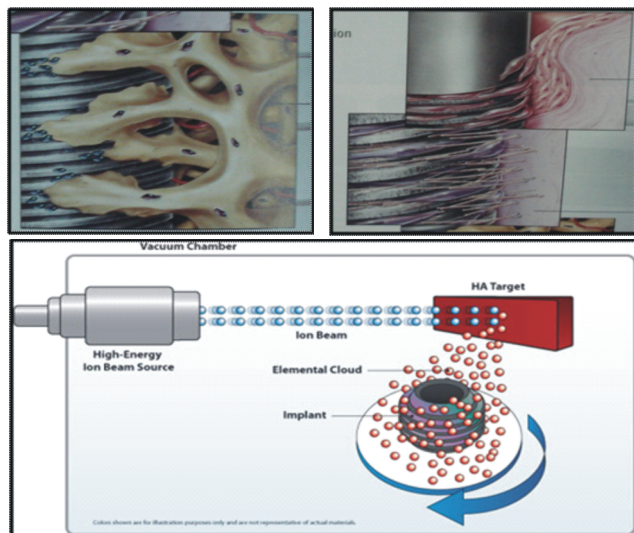
#### Laser-Machined Microtexture

Laser-lok bioaffinity collar for soft & hard tissue attachment.

8 Micron cell channels stops epithelial cell migration.

Soft tissues attaches & seals 8 micron cell channels.

12 Micron cell channels direct osteogenic cells to form strong attachment of organized bone.



This Ion-beam assisted deposition of nanoparticles provides increased integration with the implant surface, is known as high-energy sputter deposition.

### Nanotite Implants

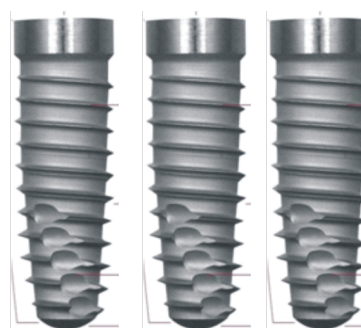
The incorporation of nanotechnology into implant dentistry has been a major break through in implant surface technology.

This technique makes use of an ion beam modification of the titanium alloy surfaces.

These threads maximize bone-to-implant contact (BIC).

The thread angle, depth and pitch produce an anchoring “bite in bone” response.

Domed apical end reduces trauma and is desirable in areas where implant placement closely approximates vital structures.



#### Advantages

Formation of a nanothin calcium phosphate compound.  
Surface thickness of less than 500 nanometers.  
Maintenance of the rough microtopography.  
Enhancement of bone integration.

### Groovy Implant Surface

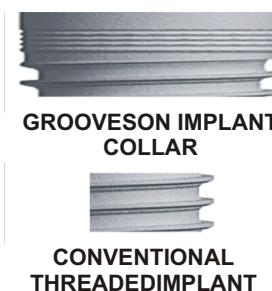
Micro-grooves placed on surfaces.

Integrate faster than implants without grooves.

Indicated in immediate or early loading.

#### Advantages

- Enhanced osseointegrative properties of the grooves form a guiding effect on bone forming cells.
- Bone forms preferentially within the grooves.
- Up to 30% increase in stability from mechanical interlock.

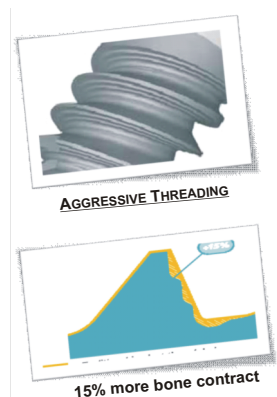


### One Piece Implant With Aggressive Threading

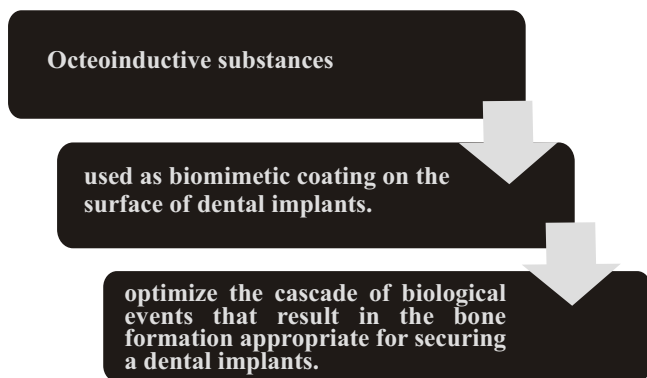
The presence of little steps on the lower side of the thread.

A very deep coil depth designed to provide increased primary stability even in soft bone.

Blood gathers into these threads, promoting the precocious formation of bone tissue and thus faster osseointegration.



### Tissue Engineering Strategies



### CONCLUSION

- Higher BIC for HA and TPS implants as compared to acid etched.
- Higher BIC for HA coated implants as compared to TPS.
- Acid etched implants had higher bone response and implant fixation than machined implants.
- Greater bone formation & BIC for SLA. Superior to machined, blasted & TPS surfaces & greatest bone contact percentage of metal surfaces tested..

### Last But Not The Least

The hunt for ideal surface is still on.....

### REFERENCES

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