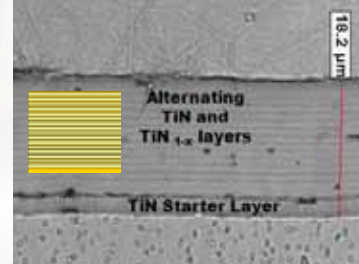
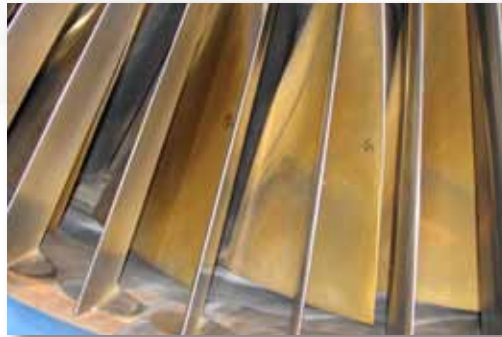


Multilayer Titanium Nitride Coatings

Liquid Droplet Erosion Protection for Power Generation



TiN 24k Type II™ multilayer coating architecture. Alternating substoichiometric and stoichiometric TiN layers form a thick erosion-resistant coating.



TiN 24k Type II™ coated 7FA R0 blades

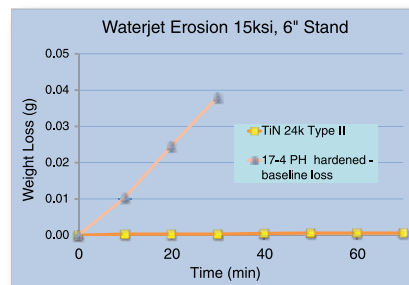
Modern power generating gas turbines utilize water fogging to augment performance (efficiency). Water droplets impacting the leading edge of the compressor blades cause liquid droplet erosion (LDE) of the base metal. This erosion can lead to a reduction of the chord width over extended periods of operation and possibly lead to fatigue crack issues.

Praxair has been applying erosion-resistant coatings such as TiN, TiCN, TiZrN, TiAlN, and TiAlCN by cathodic arc physical vapor deposition (CAPVD) or other physical vapor deposition (PVD) processes since the early 1990's to prolong the life of compressor airfoils in a sand erosion environment. These coatings also offer superior protection against liquid droplet erosion.

For example, test data show that our multilayer TiN 24k Type II™ coating for 7FA R0 compressor blades, protects the leading edge against liquid droplet erosion, in excess of 25,000 EOH in a severe coastal, fogging, and water-wash operating environment.

Advantages

- Substoichiometric coating composition offers improved erosion resistance due to increased hardness, higher toughness, and reduced compressive stress
- By using a multilayer architecture (24k Type II), the total coating thickness can be significantly increased for improved protection at moderate compressive stress levels
- Using a coating composition based on titanium alone allows us to minimize equipment and production costs and thus significantly increase production speed and production lead time compared to more complex multi-element coating compositions
- Solid particle erosion testing and liquid droplet erosion testing by waterjet provides a comprehensive representation of the coating erosion protection properties, which allows for the optimization of coating architecture.



Liquid droplet erosion of hardened 17-4 PH SST versus TiN 24k Type II™ in a waterjet erosion test.