

Platinized Titanium and MMO Anodes in Electroplating Applications



Umicore products are available throughout North America exclusively through



The world of noble and functional surfaces



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HTE Platinized Anodes

MMO Anodes

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Comparison

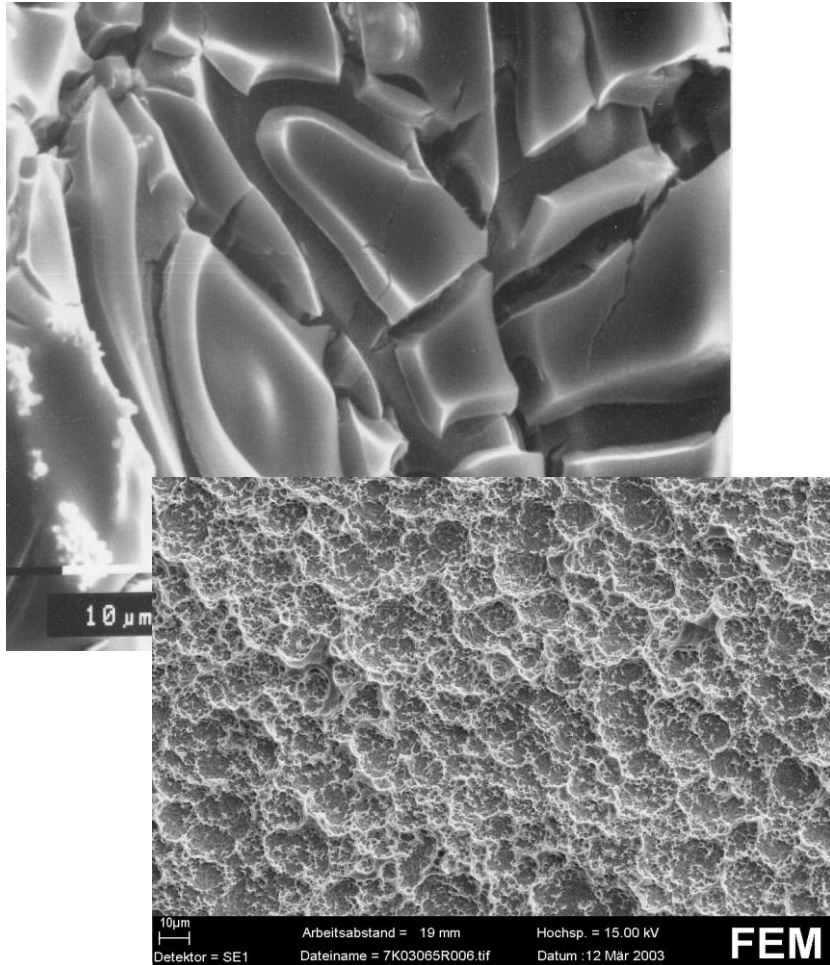
HTE Platinized Anodes vs. MMO Anodes

Comparison

| | <u>M</u> ixed <u>M</u> etal <u>O</u> xide Anodes | Platinized Anodes |
|------------------|--|----------------------------|
| Electro Catalyst | Ir-oxide and/or Ru-oxide mixed with Ta-oxide and/or Ti-oxide etc. | Pure Platinum >99,8% |
| Layer | Sandwich Layers Setup | Platinum crystal structure |
| Adhesion | Pure Mechanical Adhesion | Physic-Chemical Adhesion |
| Coating process | Manual: Paint Brush, Spray or Roller Coating + Thermal Conversion Process | Electrolytic Deposition |

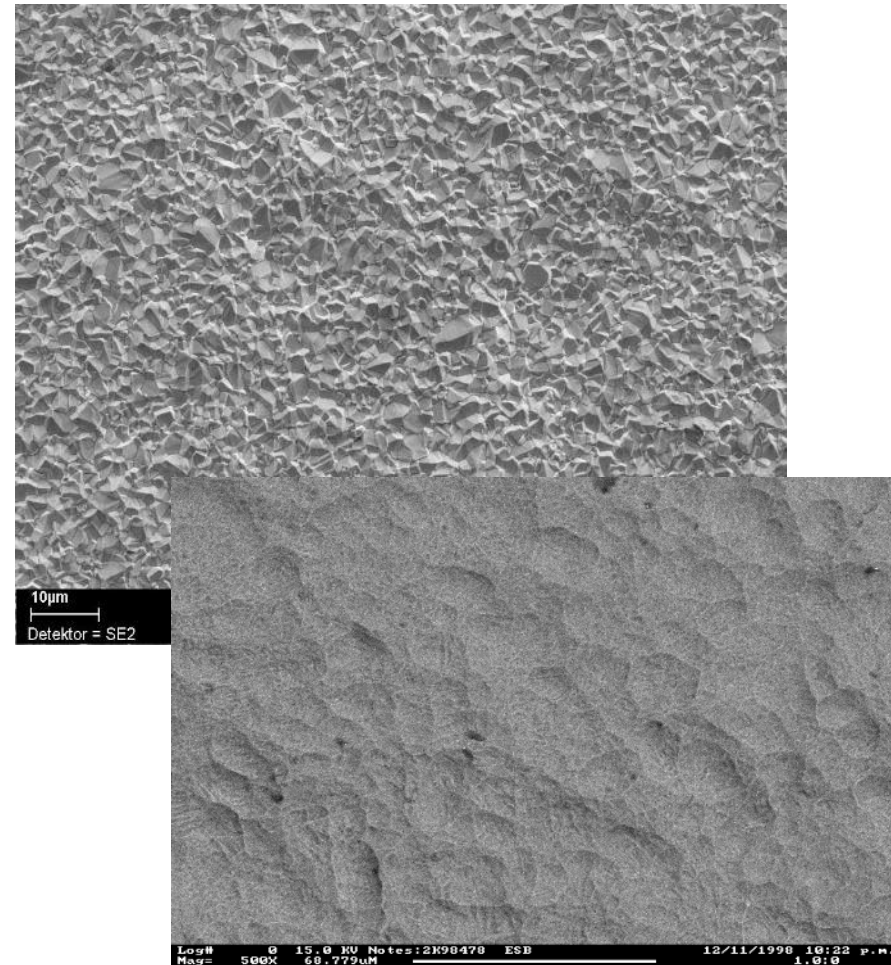
Comparison

MMO- layer:



Ti-base-metal surface:

HTE-Platinum- layer:



Ti-base-metal surface:

HTE Platinized Anodes

Composition and Properties

Metal deposition from Umicore's HTE process

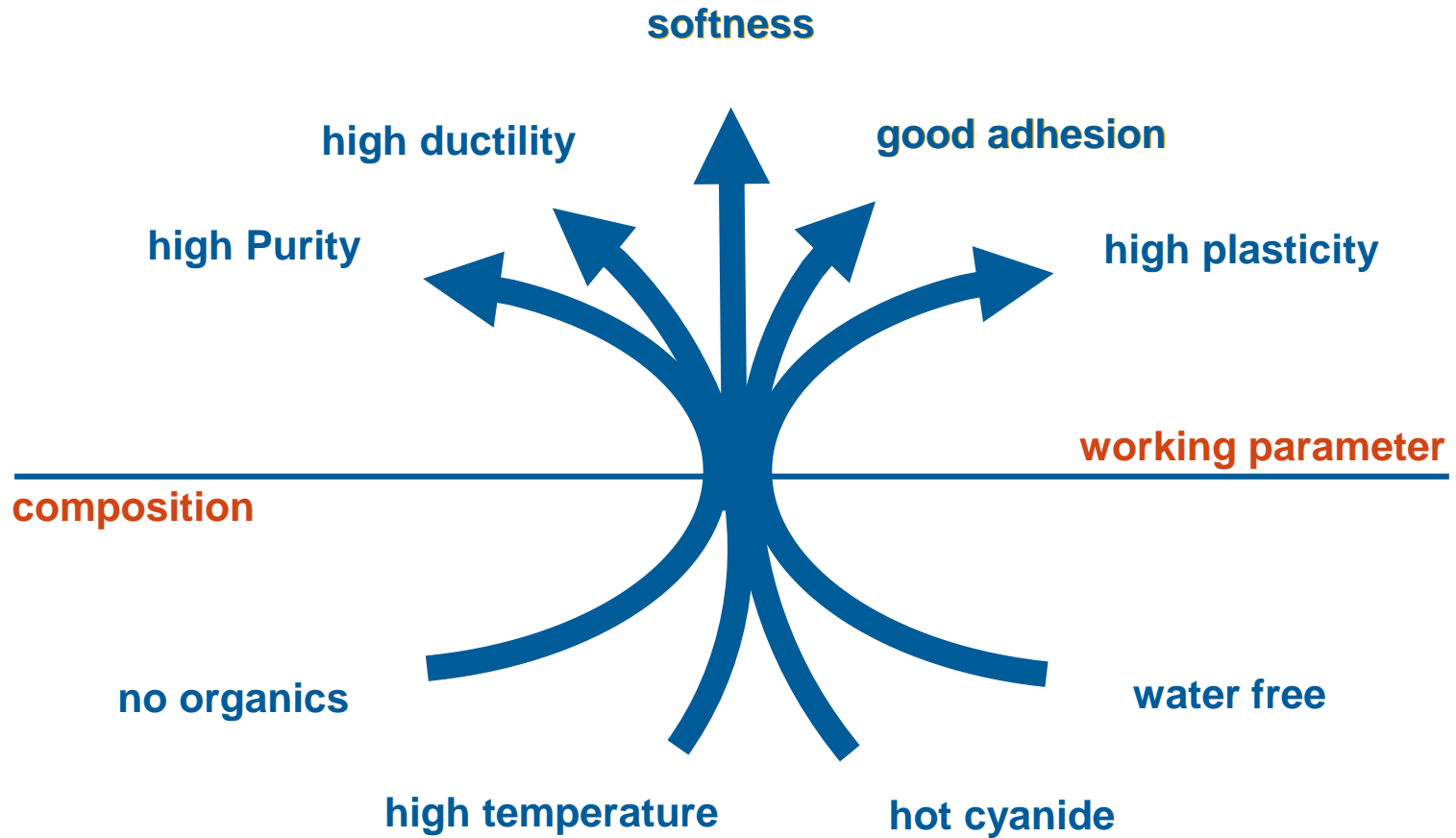
Process parameters

| | |
|--------------------------|----------------------------------|
| electrolyte composition | 52 % KCN 48 % NaCN 1-3% Pt |
| operation temperature | 500-600 °C |
| cathodic current density | 1-5 A/dm ² |
| deposition rate | 10-50 μm/h |
| deposition voltage | 0.1 - 2.0 V |

Composition and Process Parameter resulting in excellent Coating Properties

Properties of HTE-platinum coatings

Factors of influence



Enables High Quality Platinum Layer

Properties of HTE-platinum coatings

| properties | Coating method | |
|--------------------------|-----------------------------|------------------------|
| | HTE-Platinum | Aqueous Platinum |
| purity | 99,99 % | 99,4 % |
| ductility | 5 % | < 0,1 % |
| hardness | 80 HV _{0,05} | 500 HV _{0,05} |
| electrolyte conductivity | high | Low |
| adhesion | high | Low |
| internal stress | -- | > 50 N/mm ² |
| plasticity | Can be plastically deformed | brittle |

Creates High-end Platinized Anodes with Best Performance and Service Life

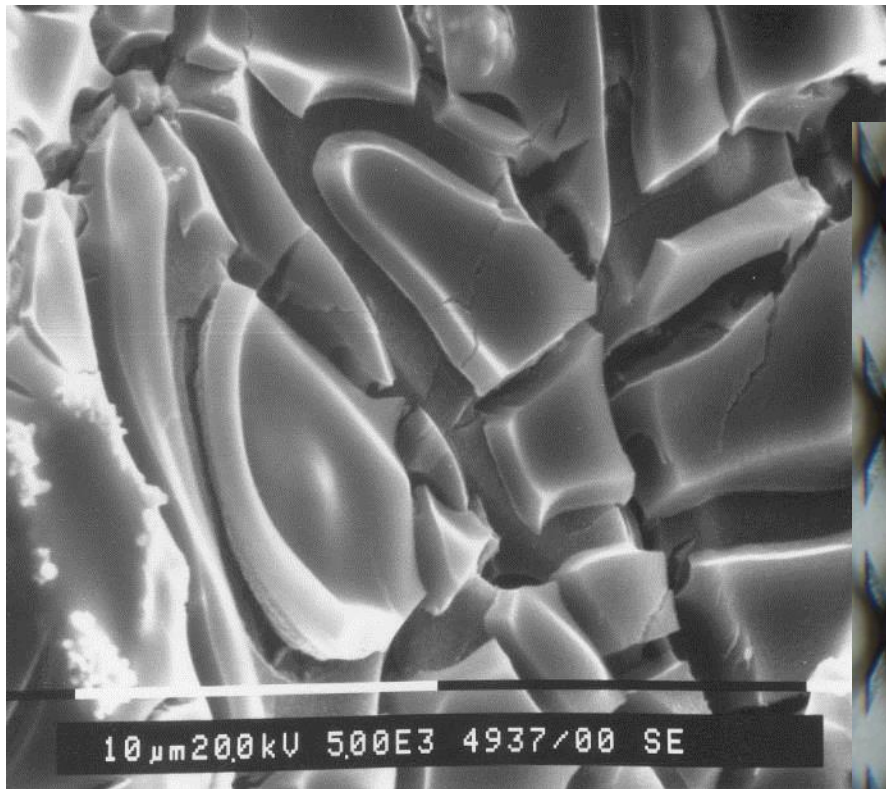
The HTE Platinum Coating delivers excellent performance and a long service life. It is the best platinized Anode quality available, at a reasonable price.

MMO Anodes

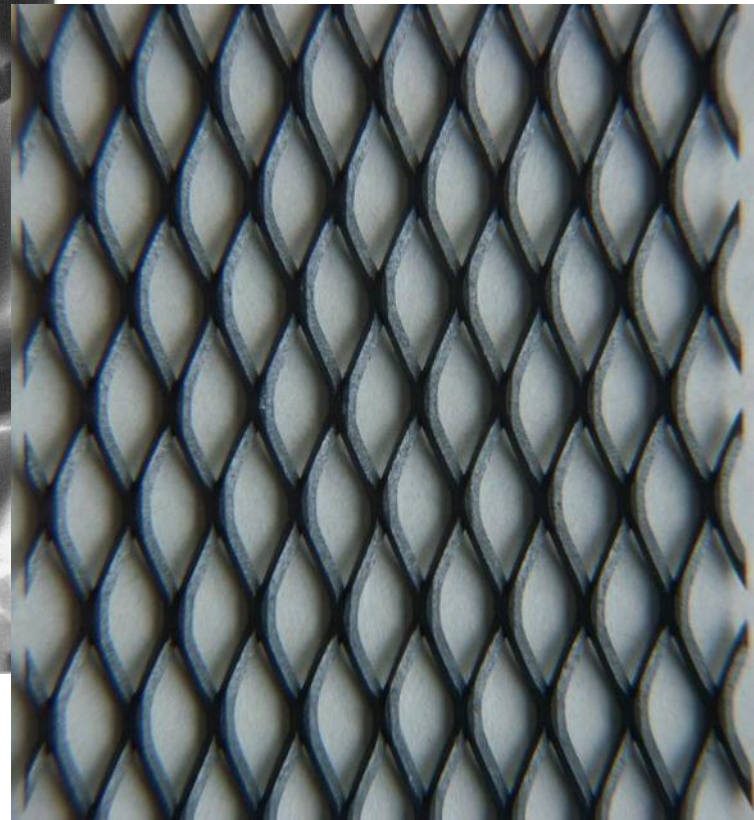
Quality and Features

Layer Structure of MMO Coating

REM-picture of MMO-microstructure:



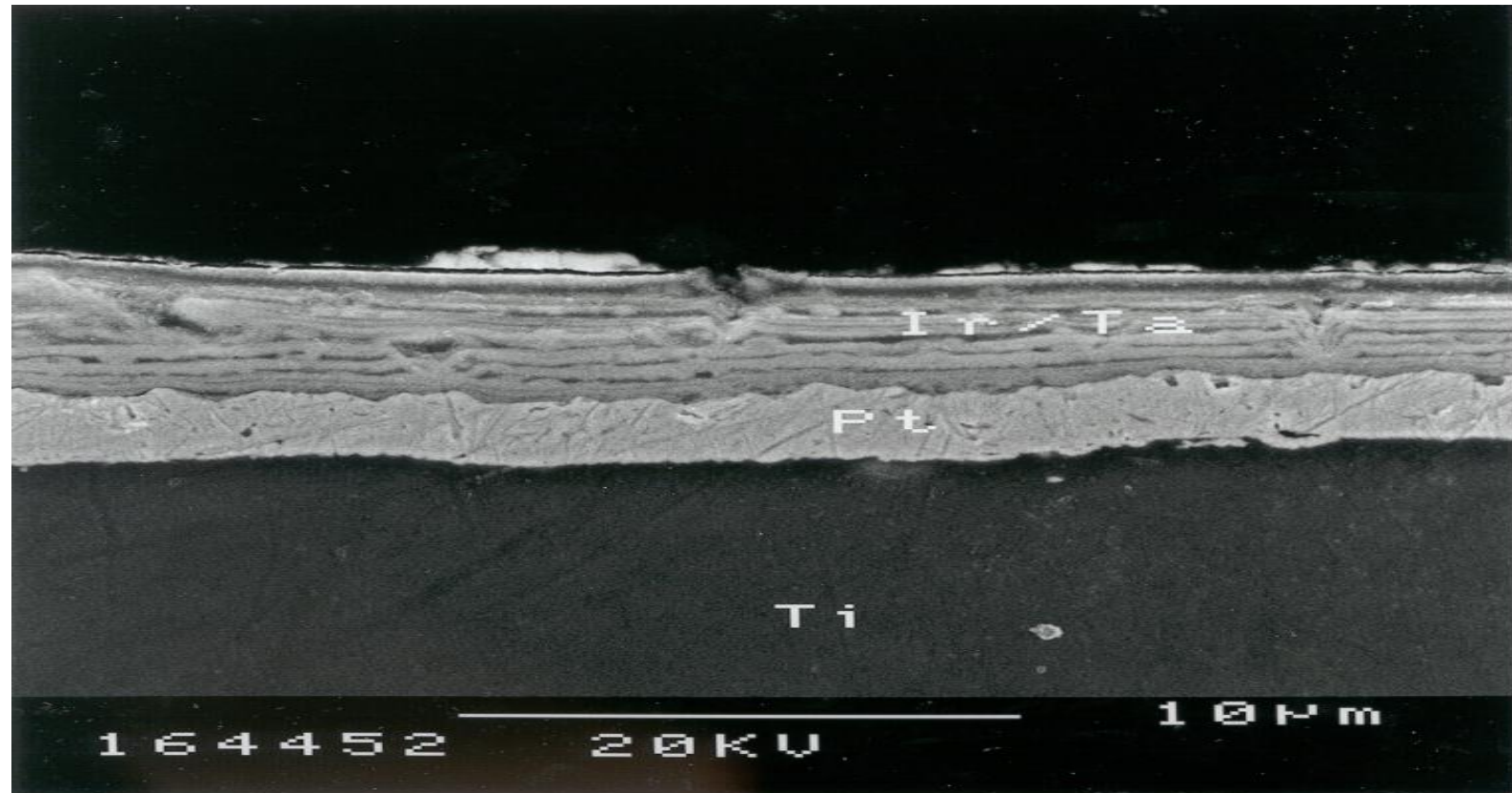
Picture of MMO-Mesh Type N:



Cracked Layer Structure Requires Sandwich Setup

Layer Structure of MMO Coating

Sandwich Layer Setup



Umicore's Layer Setup shows highest Quality and Corrosion Resistance

Umicore Standard MMO Coating Types

| | |
|-------------------------|---|
| Platinode® 187 SO / LOC | Optimized anode coating for low organic consumption avoids undesirable anode reactions |
| Platinode® 177 | Excellent behavior in acidic electrolytes |
| Platinode® 167 | Excellent behavior in alkaline and cyanide electrolytes |
| Platinode® 147 | Used for weak acidic / alkaline electrolytes |
| Platinode® 197 | For different kind of water electrolysis |
| Platinode® 197SN | High performance in cooling water systems |

In addition to standard MMO coatings, we develop coatings customized to the application.

MMO Features

- Long service life in acidic solutions
- Low organic consumption / low oxygen evolving potential
- Undesirable anode reactions can be avoided
- More cost effective than PtTi anodes
- Less precious metal consumption
- Excellent cost benefit ratio for a broad range of applications


MMO anode coating is ideal for numerous electroplating and other applications, and an excellent alternative to platinized anodes, at a lower cost.

Future requirements for electrolyte-protective and gentle anode systems can be met with Umicore MMO anodes

Typical Applications

General Overview

Typical applications

|  umicore | Platinierteres Titan Platinized titanium | Platinierteres Niob Platinized niobium | Iridium-Mischoxid Iridium mixed oxide | Ruthenium-Mischoxid Ruthenium mixed oxide | Membran Anode Membrane anode |
|---|---|---|--|--|---------------------------------|
| Rutheniumbäder, stark sauer Ruthenium baths, strongly acid | | 1,5/2,5 µm | 177 | | |
| Platinbäder, stark sauer Platinum baths, strongly acid | | 1,5/2,5 µm | 177 | | |
| Rhodiumbäder, stark sauer Rhodium baths, strongly acid | 2,5 µm | 1,5/2,5 µm | 177 | | |
| Goldbäder, stark sauer Gold baths, strongly acid | | 1,5/2,5 µm | 177 | | |
| Goldbäder, schwach sauer Gold baths, weakly acid | 1,5 µm | | | 147 | 177 DMT |
| Goldbäder, alkalisch Gold baths, alkaline | 1,5 µm | | | 147 | |
| Bronzebäder, cyanid. alkalisch Bronze baths, cyanide-alkaline | | | | 167 | |
| Bronzebäder, cyanfrei Bronze baths, cyanid-free | | | 187 LOC | 167 | |
| Silberbäder, cyanid. alkalisch Silver baths, cyanide-alkaline | | | | 167 | |
| Sauer Kupfer Acid copper | | | 187 SO 187 LOC | | |
| Halogenhaltige Electrolyte Halogen-containing electrolytes | | 2,5/5,0 | 177 | | |
| Hartverchromung fluoridfrei Hard chromium plating, fluoride-free | 2,5/5 µm | | | | |
| Hartverchromung halogenhaltig Hard chromium plating, halogen-containing | | 2,5/5,0 | | | |
| Verchromung Cr ³⁺ -haltig Chromium-plating, containing Cr ³⁺ | | | 187 LOC | | |
| Zink/Zinklegierungsbäder, alkalisch Zinc/Zinc alloy bath, alkaline | | | 177 187 LOC | | |
| Pd, Pd/Ni-Bäder, ammoniakalisch Pd, Pd/Ni baths, ammoniacal | | | 187 SO | | |
| Pd/Ni-Bäder (ACF) ammoniumfrei, chloridfrei Pd/Ni baths (ACF) ammonium-free, chloride-free | | | 187 SO | | 177 DMT |
| Nickel/Nickellegierungsbäder Nickel/nickel alloy baths | 1,5 µm | | 177 187 LOC | | |
| Trinkwasseraufbereitung Drinking water conditioning | | | | 197 | |
| Schwimmbadwasseraufbereitung Treatment of swimming pool water | | | | 197 | |
| Cyanidische Abwässer Cyanide waste waters | 1,5 µm | | | | |
| Elektrolytische Edelmetallrückgewinnung Electrolytic precious metal recovery | | | 177 | | |
| Anodisieren Anodizing | 1,5/2,5 µm | | | | |