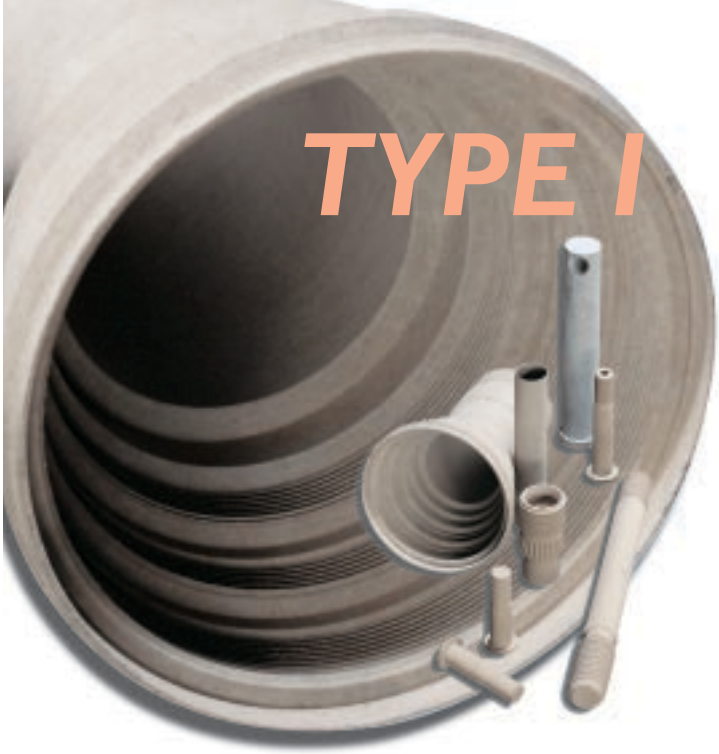
II. TIODIZE PROCESSES AND THEIR USES

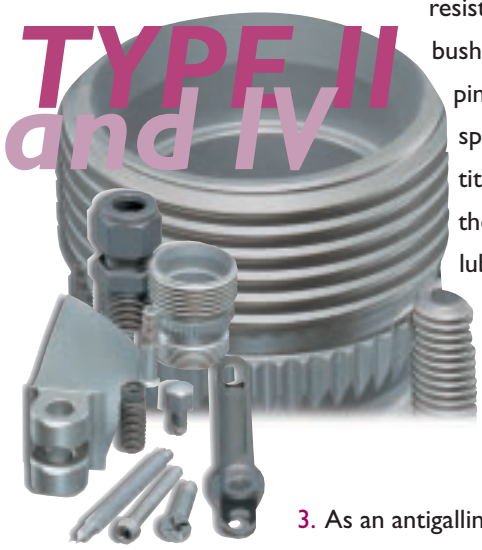
Engineers have reached a most important decision to use the TIODIZE PROCESS on all titanium parts.



II. TIODIZE PROCESSES AND THEIR USES

TIODIZE TYPES

TIODIZE *Type I* is electrically semiconductive, exhibiting a resistivity of between 10^7 and 10^8 0hm-centimeters. The effective thermal conductivity is O.40 Btu ft. hr. degrees F.



TIODIZE *Type I* can be used as a pretreatment for titanium during cold extrusion, hot forging and drawing operations. After applying a solid film lubricant to the TIODIZE Type I surface, cold reduction of 50% in one draw is achieved without annealing.

TIODIZE *Type II* resistivity is 4.5 Ohms per square inch of surface contact.

TIODIZE *Type II* may be used as an antigalling coating on titanium surfaces lubricated with oils, greases, hydraulic fluids, or in pneumatic systems. Typical usages are on titanium valves, hydraulic systems, servomechanisms, pumps, actuators, sliding bearings, acme screw rods, gears or other components requiring lubrication.

TIODIZE *Type III* has been made available to achieve a spectrum of colors. Type III is an entirely different process which is produced in an acid bath. Colors can be used to identify titanium or titanium alloys allowing the customer to differentiate immediately between materials. Colors also can be used in commercial fields for cosmetic purposes.

TIODIZE *Type IV* is TIODIZE Type II with TIOLON X40 PTFE impregnated into the surface of titanium. It provides low friction and antigalling characteristics at high loads.

USE OF THE TIODIZE PROCESS:

1. As a pretreatment for dry film lubricants in general and with the vacuum compatible dry film lubricant in particular. This combination gives optimum wear resistance on titanium parts such as cams, bushings, splines, dowels, gears, ratchets, pins, hinges and other parts to be used in space. If the matching part is also made from titanium, this part should also be coated with the TIODIZE PROCESS plus a TIOLUBE solid film lubricant.

2. As a protective finish against chemical attack of hypergolic fuels such as hydrazine and nitrogen tetroxide.

3. As an antigalling coating on titanium surfaces to be lubricated with oils, greases or hydraulic fluids such as: titanium hydraulic bearings, acme screw rods, gears or other components requiring wet lubrication. Optimum wear life can be obtained if one of the sliding surfaces is made from a self-lubricating composite such as glass reinforced teflon.

4. As a surface preparation for various paints, emissivity coatings, thermal-control, absorptance and emittance, and solid film lubricants.

II. TIODIZE PROCESSES AND THEIR USES

INTERFERENCE FIT FASTENERS

One of the major aircraft manufacturers faced the difficult problem of using straight-shank interference fit Ti-6Al-4V fasteners in the all titanium fatigue-resistance wing of one of the most advanced jet fighters, the F-14. The inherent galling problems of titanium against titanium and the prohibitive cost of drilling holes in titanium with close tolerances to achieve a fatigue-resistant wing, were the major constraints. Earlier evaluations confirmed that the interference fit range could go from .002ý to as high as .0045ý without impairing safety. This could only be done provided that proper antigalling materials be found for pushing titanium bolts into undersized titanium holes and back out again without any galling. Many pretreatments and solid film lubricants were evaluated; only the combination of **TIODIZE *Type II*** plus TIOLUBE 58 passed the performance test. The installment load required to push a 1/4 inch diameter titanium bolt through a .0045 inch interference fit hole of annealed Ti-6Al-4V plate was 1850 pounds.

Superior lubrication allowed Grumman Aircraft to build an all titanium fatigue-resistant wing that proves itself daily.

IMPROVED SURFACE FINISH – TITANIUM TURBINE AND ENGINE BLADES

The **TIODIZE *Type II*** Process has been found to improve surface finish of titanium blades by more than 50%. The TIODIZE PROCESS can reduce surface finish from a 32 RMS to a 12 RMS without any special vibratory methods.

By achieving the low RMS finish, TIODIZE PROCESS enables the turbine blades to better air flow characteristics and improved abrasion and erosion resistant qualities. Tests prove that after applying a TIOLUBE solid film lubricant to the root area of a TIODIZED titanium blade, fretting wear is prevented. Figure 2-1 illustrates a **TIODIZE *Type II*** treated turbine wheel.

This allows the turbine wheel to be press fitted and removed from a shaft (for balancing) without galling.

Since the TIODIZE PROCESS does not have to be stripped in order to reprocess the part, the TIODIZE PROCESS is ideal for maintenance and overhaul. The blades can be reprocessed without any loss of dimension or fatigue. Cost can be greatly reduced with the following improvements.

- In surface finish.
- Reduction in abrasion and erosion.
- Prevention of fretting wear.

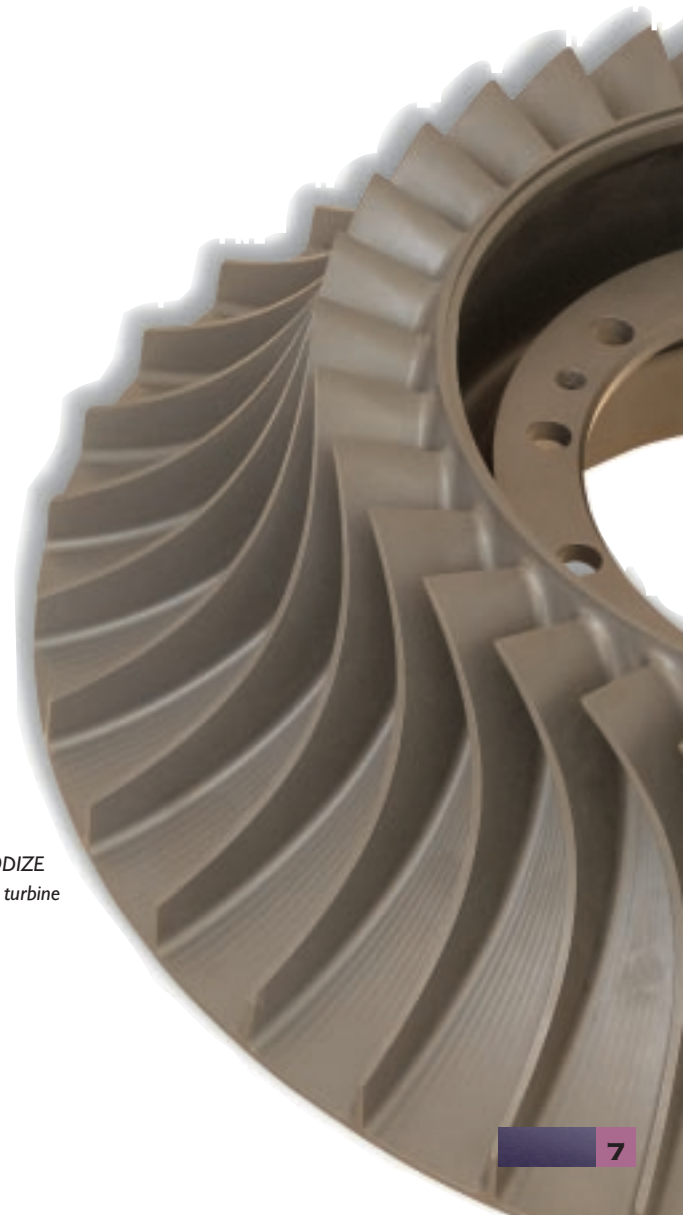
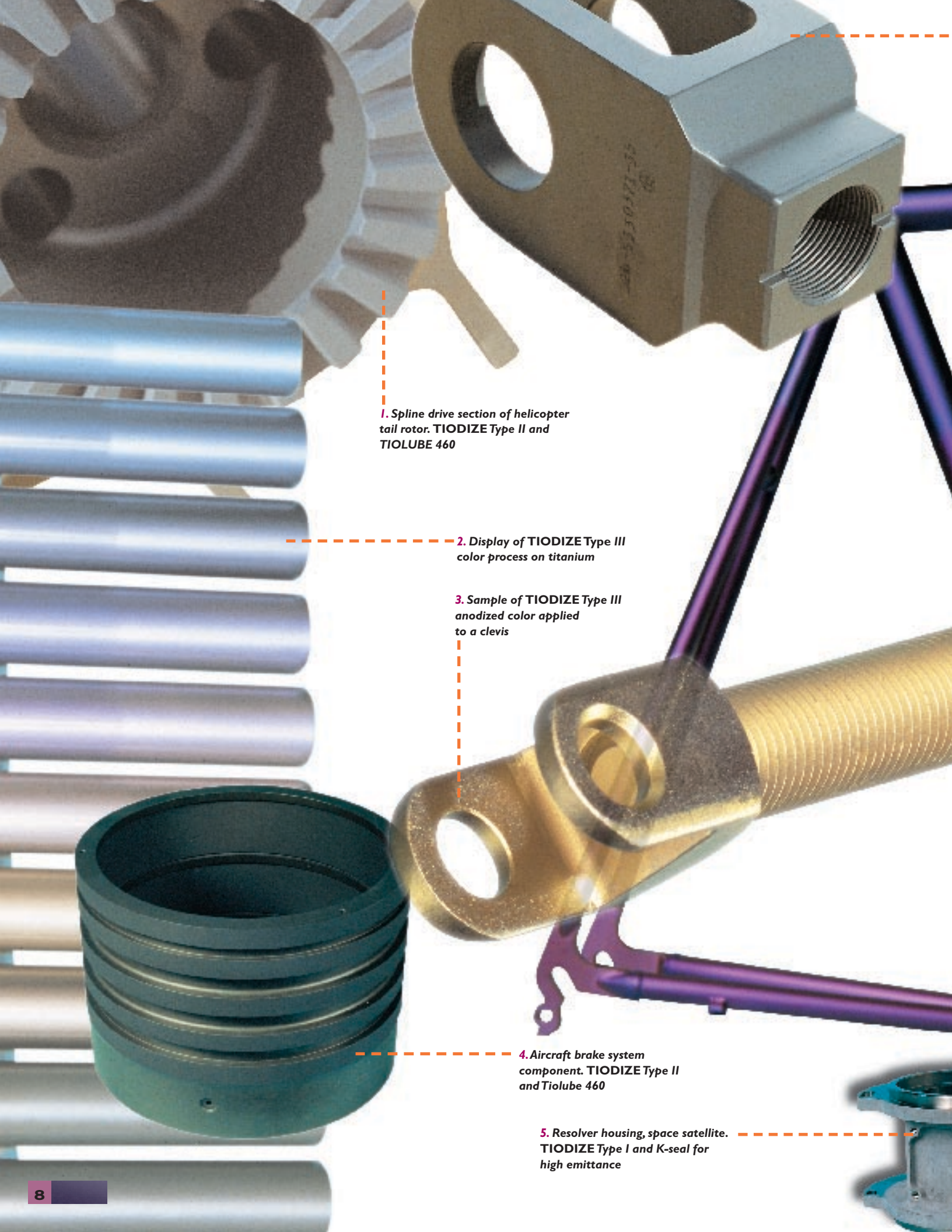


Figure 2-1 TIODIZE Type II treated turbine wheel



1. Spline drive section of helicopter tail rotor. **TIODIZE** *Type II and TIOLUBE 460*

2. Display of **TIODIZE** *Type III color process on titanium*

3. Sample of **TIODIZE** *Type III anodized color applied to a clevis*

4. Aircraft brake system component. **TIODIZE** *Type II and Tiolube 460*

5. Resolver housing, space satellite. **TIODIZE** *Type I and K-seal for high emittance*

5. Helicopter blade assembly clevis. TIODIZE Type II

II. TIODIZE PROCESSES AND THEIR USES

6. Medical bone screws and implants. TIODIZE Type II

TIODIZE Co., Inc. has been providing excellent service to all industries since 1966 and we continue to be the leader in the field.

Others may try to meet the stringent requirements of AMS 2488, but if constant, proven dependability and satisfaction is your need, specify TIODIZE.

2. Optical lens component for space. ***TIODIZE*** *Type II*

4. Titanium frame, racing bicycle. ***TIODIZE*** *Type III*

3. Jet engine transmission bearing component. ***TIODIZE*** *Type II*

1. Helicopter main rotor hub. TIODIZE Type II and TIOLUBE 460