Medical - Neodymium Iron Boron Magnets

Neodymium Iron Boron Magnets are one of the most powerful commercial permanent magnets available today. These rare earth magnets can be up to 10 times stronger than the strongest ceramic magnet. NdFeB magnets are typically produced using one of two general method categories, bonded magnets (compression, injection, extrusion or calendaring molding), and sintered magnets (powder metallurgy, PM process). NdFeB magnets are commonly used in products that require strong permanent magnets such as hard disk drives for computers, electric motors in cordless equipment, and fasteners. For medical component applications new uses of these powerful magnets are emerging. For instance, catheter navigation, where magnets can be integrated into the tip of a catheter assembly and controlled by external magnetic systems for steerability and deflectability. Other uses in the medical field include the introduction of open magnetic resonance imaging (MRI) scanners which are used to map and image anatomy, as an alternative to superconducting magnets which typically use coils of wire to produce a magnetic field. Additional uses in the medical device field include, long and short-term implants, and minimally invasive devices. Some minimally invasive applications for neodymium iron boron magnets are endoscopic assemblies for a myriad of procedures including; gastroesophageal, gastrointestinal, skeleton, muscle and joints, cardiovascular, and neural.

The Challenge

Neodymium magnets are reactive to acids, humidity, basic solutions, electrical currents, human tissue and even react just in open air. NdFeB alone is not biocompatible for medical device applications in the human body. The best way to ensure safe use of neodymium magnets in the body is to coat a biocompatible layer on the exterior of the magnet that hermetically seals the magnets. Various electroplaters across North America have attempted the process of plating these magnets for that purpose with little success. There are companies in Asia that offer this service with oftentimes poor process control and quality management, only adding to the risk of overseas supply chain control. An alternative to metalizing magnets is to use a perylene coating process as commonly used in the medical industry, perylene coating refers to organic coating materials with a polycrystalline or linear structure. A layer of perylene coating is less preferred in comparison to plating due to plating thickness build up being thinner, and the inconsistent corrosion protection that the perylene coating provides. Unfortunately, this alternative process of coating perylene on NdFeB typically results in pinholes from the porosity in the base material.

ProPlate worked with a medical customer that needed to achieve a biocompatible protective surface for NdFeB magnets, which were used in a short-term implant application. Due to the porosity of the base magnet material combined with the reactivity of the magnets to acidic and basic chemistries; ProPlate faced a difficult challenge designing a plating process for the Neodymium magnets. Throughout the plating process is it necessary for adequate adhesion to use acidic and basic chemistries in order to remove surface oxide, which NdFeB rapidly forms without any protective coatings. Furthermore, properly handling the magnets in an environment so that the magnets wouldn’t oxidize in the process steps or in the queue to be plated added more complexity to the project.

The Engineered Solution:

Due to the porosity of the magnet base material developing a plating process resulting in the magnets becoming hermetically sealed required tight process control to be adhered to, and stringent validation testing to determine true successful outcomes. A major obstacle ProPlate faced was finding the precise balance of chemicals during the plating process. The key was to develop a chemical process aggressive enough to promote the best adhesion, but mild enough
to not cause corrosion to the magnetic base material. Porosity in a metal base material is
undesired and requires tailored plating processes for success. Using various plating methods,
specific agitation, and use of custom fixtures and plating apparatuses were required to address
the porosity. Multiple development trials were applied to the magnets for the ideal combination
of metallic underlayers before applying the final Gold layer. The best method was to use a
combination of nickel, copper, nickel layers, followed by gold. Gold being the ideal final layer
because Gold is a commonly used biocompatible metal in the medical device industry, and it
offers superior corrosion protection due to its inertness. Another key for the unique process was
finding the electroplating techniques that offered the most uniform deposition and leveling to
combat porosity. Using a saline soak test, ProPlate tested all plated magnets to validate that the
magnets could withstand a final series of corrosion testing like its intended use in the human
body. An unprotected magnet would show signs of corrosion almost immediately in an
accelerated saline soak test. ProPlate’s magnets in some instances have lasted months in the
saline soak test, which far exceeds the typical accelerated saline soak 72-hour test duration at
50 degrees Celsius.

Applications:

- Computer Hard Drive Magnets
- Microphones
- Headphones
- Dentures
- Loudspeakers
- Magnetic Pump Couplings
- Door Catches
- Magnetic Suspension
- Motors & Pumps (e.g. washing machines, drills, food mixers, vacuum cleaners,
  hand dryers, medical devices)
- Generators (e.g. Wind turbines, Wave Power, Turbo Generators, etc)
- Sensors
- Orthopedics
- Halbach Arrays
- Jewelry
- Healthcare
- MRI and NMR applications
- Magnetic Separators
- TWT (Transverse Wave Tube)
- Magnetic Bearings
- Lifting Apparatus
- Limpet Pot Magnets
- Starter motors
- ABS systems
- Fans Eddy Current
- Brakes
- Alternators
- Meters
- Magnetic Clamps
- Magnetic Levitation
- Electro-acoustic pick-ups
- Switches
- Relays
- Catheter assemblies and components
- Catheter tips
- Surgical components and minimally invasive devices
- Endoscopic assemblies
- Hard disk drives
- Electric motors in cordless equipment
- Fasteners