Ion Nitriding

As a general provider of heat treatment and machining services for various products including dies and molds, jigs and tools, precision machinery components, and magnetic materials, Daido has facilities for performing all types of heat treatment such as vacuum heat treatment furnaces, and our network of domestic heat treatment centers meets a wide range of diverse and advanced user needs.

Ion Nitriding Method

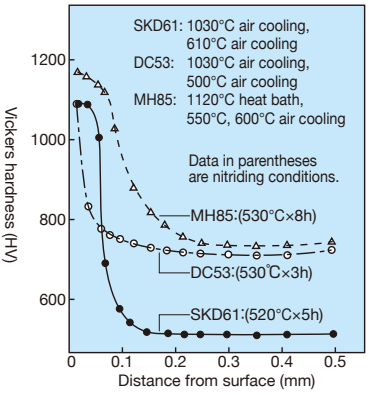
When voltage is applied to a gas atmosphere consisting of a low-pressure mixture of N2 and H2 inside a vacuum furnace, the treated objects act as the cathodes and the furnace wall acts as the anode, causing a glow discharge and generation of ions. The ions are bombarded against the surface of the treated objects, generating heat and nitriding the surface.

Features of Ion Nitrided Objects

- An optimal nitride layer can be formed according to the application of various items such as dies and molds, jigs and tools, and machinery components.
- By changing the amount of nitrogen gas, the amounts of ε (Fe2-3N) and γ' (Fe4N) generated can be adjusted.
- In the case of dies and jigs subject to impact, the amount of tough γ' is increased and weaker ε is minimized.
- In the case of components that require sliding wear resistance or corrosion resistance, the ε layer can be made thicker, something that is not possible with other nitriding techniques.
- The ion nitride layer is extremely dense, and the porous layer seen in nitride layers created with other techniques is not present.

Hardness of the Ion Nitride Layer

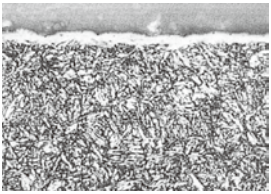
If SKD61 hot work tool steel, DC53 cold work tool steel, or MH85 high-speed tool steel is quenched and tempered and then subject to ion nitriding, the surface hardness distributions are as shown in the figure.
The nitride surface hardness of each of the three steel types, processed under the respective nitriding conditions, is increased to at least 1,100 HV. The depth of the hardness is approximately 0.2 mm for the SKD61 and MH85 and approximately 0.1 mm for the DC53.



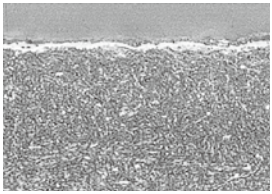
Ion Nitride Layer Hardness Distribution

Optical Microstructure

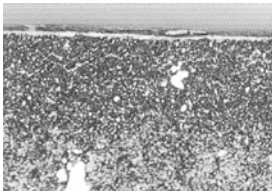
According to the results of X-ray diffraction measurements of the optical microstructure of the nitride surface layers of three nitride test steel samples (photos), the nitride formed on the SKD61 and MH85 has more γ' and less ε, while the DC53 has a small amount of ε and the remainder is γ'. In this way, the nitride layer can be formed with more tough γ' on metals that will be used for dies.



SKD61



MH85



DC53

Photos: optical microstructure of ion nitride layers (× 400)

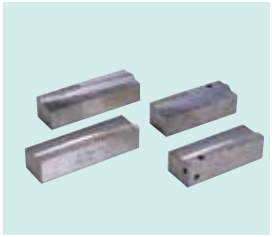
Examples of Ion Nitriding Applications

Cold and Hot Work Dies

Extrusion: pressing, die casting, forging, powder formation, plastic dies, etc.

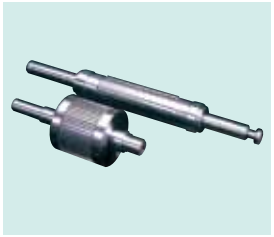
Cutting Tools

End mills, drills, hobs, milling cutters, rolling dies, etc.



Machine Components

Drive shafts, rollers, spline shafts, gears, pinion Zs, etc.



Examples of Ion Nitriding Effects

Application/product	Material	Effects
Hot forging die	MH85, DH32, SKD61	Compared to untreated: 2–4 times longer life
Cold forging die	MH85, DC53	Compared to untreated: 3–4 times longer life
Fiber machine component	SUS420J2, SUS431	Countermeasure against gas nitrocarburizing unevenness
Rolling die	DC53	Compared to untreated: 50% longer life
Cold drawing punch and die	DC53	Good seizing resistance

Ion Nitriding Facilities

Osaka Heat Treatment Center Ion Nitriding Furnaces

Machine No. 1
Output: 200 V × 35 A
Furnace interior dimensions: ø500 × 700 H
Maximum treatable mass: 300 kg (including jigs)

Machine No. 2
Output: 200 V × 130 A
Furnace interior dimensions: ø650 × 1,100 H
Maximum treatable mass: 300 kg (including jigs)