TECHNICAL INSIGHTS

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ADVANCED COATINGS & SURFACE TECHNOLOGY ALERT

RARE EARTH ION IMPLANTATION--NOVEL SURFACE MODIFICATION TECHNIQUE

Bearings are a key component in most manufacturing and processing applications. When the surfaces of these bearings get degraded beyond a certain limit, the life of it gets reduced. Wear and corrosion are the main failure mechanisms of bearings--and to minimize this effect, measures have been proposed to prolong their working lifetime. Some of the possible approaches include the use of expensive materials, ion implantation, surface finish enhancement, and ion beam assisted deposition. Of all the approaches, ion implantation is used extensively to modify the surface and properties of materials. Studies on the same have proved that the bearing steel surface can be strengthened by ion implantation of different elements such as nitrogen (N), molybdenum (Mo), N and Mo, and so on.

More recently the use of rare earths has gained sufficient attention for them to be used as reinforcing elements in applications such as plating, chemical heat treatment, and thermal spraying. One such example is the use of rare earth in ion implantation to enhance the high temperature oxidation behavior of metals and also to improve the aqueous corrosion resistance. However, not many studies have been made to systematically analyze the use of rare earth ion implantation on the mechanical properties and chemical stability of bearing steels.

A team of researchers from the City University of Hong Kong has developed a new way to improve the surface properties of high-temperature bearing steels. Rare earth ions including praseodymium (Pr), lanthanum (La), and neodymium (Nd) have been implanted into $W_9Cr_4V_2Mo$ high-temperature bearing steel specimens using a metal vapor vacuum arc source. The researchers have studied the effects of ion implantation of rare earth elements such as Pr, La, and Nd, on the surface hardness, tribological behavior, corrosion resistance, and wear resistance of $W_9Cr_4V_2Mo$ bearing steels.

X-ray photoelectron spectroscopy results show the implanted surface as containing the rare earth oxides. Also, the modified surfaces prove to have better wear resistance, possibly due to the smoother and harder surface. However, the enhancement of the corrosion resistance in 3.5 wt.% NaCl aqueous solution after ion

implantation was not appreciable as the corrosion resistance of $W_9Cr_4V_2Mo$ bearing steel was found to be dominated by the chromium present in the bearing steels. At the end of ion implantation, all the implanted samples showed increased microhardness of 20% to 30%. More work is to be done to further refine the process.

"This is a new technique for a widely used 'traditional' material. It provides an alternative and potentially better means to improve the surface properties of high-temperature bearing steels," says Paul Chu, Professor of Materials Engineering, Department of Physics and Materials Science, City University of Hong Kong, Hong Kong.

This is a piece of joint collaborative work with City University of Hong Kong and Southwestern Institute of Physics in China. No patents have been filed as yet for this work. The researchers plan to improve the technique further to apply it to other materials.

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