Boride layers prepared on iron surfaces by ion implantation

Tamás Fodor[a], Viktor Takáts[a], József Hakl[a], Sándor Molnár[a], Márton Soha[a], Attila Csík[a], Zoltán T. Gaál[a], Zoltán Halász[a], István Rajta[a], Márton Benke[b], Kálmán Vad[a]

[a] Institute for Nuclear Research, H-4026, Debrecen, Bem tér 18/C, Hungary
[b] Institute of Physical Metallurgy Metalforming and Nanotechnology, University of Miskolc, H-3515, Miskolc, Miskolc-Egyetemváros B/1 Fszt.
fodor.tamas@atomki.hu

Boriding, or boronizing is a surface hardening method that produces protective metal-boride layers on various metal surfaces, such as iron and steel. It increases surface hardness, resistance to wear, oxidation and corrosion. Corrosion resistance is highly sought after in most industrial fields, increasing the lifetime of products and machinery. The wave-forming tips or baffles in wave soldering machines used in the manufacture of printed circuit boards are good examples. There are several methods of boriding, using various media (solid, liquid, gaseous and plasma). Pack cementation boriding is widely employed due to its ease of use and availability. The main drawback of this method is the formation of a double layer of FeB and Fe_2B, due to the amount of boron that diffuses into the various surface depths during the process.[1] There are notable differences in the crystal structures and thermal expansion coefficients of the two borides, making this double layer mechanically weak. FeB is also generally unfavourable due to its brittleness and tendency to spall.[2] We aim to solve this issue by avoiding diffusion dependent methods, instead using ion implantation for inserting boron atoms into the iron matrix under more controlled conditions. High current ion implantation is a well-known method for modifying surface layers of different metals. In this work boron ions were implanted into the surface of high-purity iron samples. We studied the boron distribution in the surface layer by depth profile analysis and the chemical bonds between iron and boron by X-ray photoelectron spectroscopy.

[1] H. Kunst, B. Haase, J. C. Malloy, K. Wittel, M. C. Nestler, A. R. Nicoll, U. Erning and G. Rauscher "Metals, Surface Treatment" in *Ullmann's Encyclopedia of Industrial Chemistry*, **2006**, Wiley-VCH, Weinheim
[2] M. Kulka, N. Makuch, A. Piasecki, *Surface and Coatings Technology*, **2017**, *325*, 515-532.