Service : Métallurgie (FPMs, Véronique Vitry, Fabienne Delaunois)

Topic: Adding self-healing ability to the electroless Ni-B coating

Objective: Electroless nickel-boron coatings have been used in various industrial sectors for their excellent mechanical and tribological properties. In some industries due to sever impact load that is applied in this coating, the crack starts to grow on the surface of the coatings which as a result reduces its mechanical properties to resist the next upcoming impact loads. In some industries it is not financially feasible to change the tools when the crack appears on its surface. Our goal in this project is to find a solution to add self-healing ability to the Ni-B coatings and reduces the growth rate of the cracks when high loads are applied on the surface of these coatings.

Literature review: Pure nickel, nickel boron, and nickel phosphorus coatings are three types of electroless nickel coatings. Depending on the reducing agent used during the chemical reduction of nickel in an electroless bath based on catalytic reaction, a different type of electroless nickel deposit can be produced. When hypophosphite is used as the reducing agent, the coating will be Ni-P, and if borohydride or amine borane compounds are used, the coating will be Ni-B. The electroless nickel boron (Ni-B) coatings have been increasingly studied over the past decades due to their applicable characteristics namely ease of coating process, uniform coating deposition on complex geometries, high hardness and amazing tribological properties. Therefore, the Ni-B coatings could be used for improving the surface properties of different substrates, especially substrates such as titanium, aluminum and stainless steels which suffer from poor mechanical properties. Despite their unique properties the need to improve their mechanical properties still needs more study.

A self-healing composite can also be synthesized by delivering a low-melting temperature alloy to the damaged region that serves as a healing agent in a high-melting temperature alloy metal matrix composite. In order to add self-healing ability to the Al alloy scholars have studied a composite consisting of an Al alloy 206 matrix reinforced with hollow ceramic tubes whose hollow spaces were infiltrated with a lower melting point Sn-40Pb solder. A hole was drilled to simulate the crack in the metal matrix running into the micro tube. The sample was then heated above the melting point of the alloy, held for 5 min, and cooled to room temperature. The solder flowed out of the micro tubes and sealed the hole. This method has so far proved challenging to perfect and needs further work on different alloys like Ni-B coating. In this work similar to their work, low-melting temperature healing agent will be produced by ball milling process and the final result will be added to the Ni-B coating as a composite agent and the self-healing ability will be studied.

References: Ferguson, J.B., Schultz, B.F. & Rohatgi, P.K. Self-Healing Metals and Metal Matrix Composites. *JOM* **66,** 866–871 (2014). https://doi.org/10.1007/s11837-014-0912-4

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