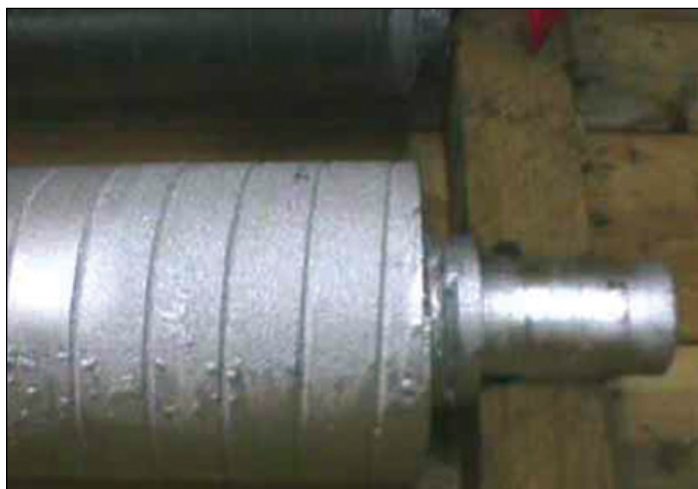


The Longest Life Non-Stick Liquid Metal Corrosion-Resistant Coating for Sink Rolls (or Zinc Pot Rolls) – Boromet™ 144

Introduction

Hot-dip galvanizing (HDG) is the process of dipping fabricated steel into a kettle or vat containing molten zinc or zinc alloys. The hot dipping is carried out at temperature greater than 430°C. In continuous galvanizing process, the steel strip is dipped in the molten bath through a series of sink rolls (or zinc pot rolls), which control the speed and tension of the strip and guide the steel strip through the molten metal bath. Since Zn at the elevated temperatures reacts with iron from the steel sheet as well as reacts with the surface of the rolls by causing dissolution, dross (alloy Zn-Fe or Zn-metal) is built up. This dross is attached to the rolls surface causing unacceptable defects in the steel sheet, since the dross particles are extremely hard (Zn hardness is 50 Vickers, steel hardness is 100 Vickers, and dross hardness is 700 Vickers). Additionally, this corrosive environment deteriorates the rolls functionality. When this happens, the line must be stopped and the rolls must be replaced.



Dross build-up on the outer edge of the roll.

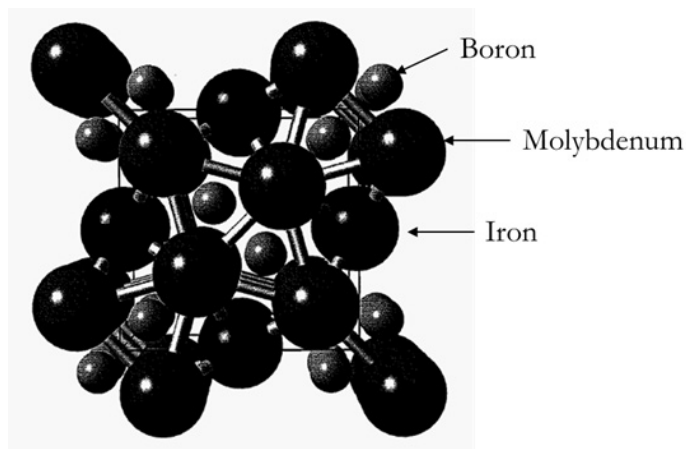
Due to this dross build-up, the quality of sheet is lowered and sheet is downgraded leading to wastage and loss, and eventually causes a grave financial set-back. To avoid this, the rolls have currently been thermally sprayed with moly-boride and/or tungsten carbide coatings with a ceramic sealant applied as an overcoat. Even after using these protective coatings, there is dross build-up and hence requires replacement of the rollers every few days, which leads to the following disadvantages:

1. Increased loss of production due to frequent stoppages and replacement
2. Zinc loss due to frequent change of roller assembly

3. Additional cost of re-machining of sink roll
4. Increased energy and time consumption since the sink rolls have to be preheated to the temperature of the bath before being inserted into the bath
5. Increase idle time in the process

Solution

Hybrid Materials LLC, known as one of the most promising material science company, has developed the ideal solution, Boromet™ 144, to solve the problem of dross build-up and corrosion in sink rolls. Boromet™ 144 product is a self-lubricating nanocomposite material with high toughness and corrosion-resistant nanoengineered boride-based ternary and binary ceramic with an adjusted thermal expansion coefficient. This combination provides chemical stability, superior thermal shock resistance, extraordinarily high-temperature molten metal corrosion resistance, and solid lubrication in applications like zinc pot rolls, metal production, metal processing, metal forming, die casting, stamping, forging, etc.



Breakthrough structure of Hybrid Materials LLC's Boromet™ 144 Coating

Boromet™ 144 near-nanocomposite cermets provide:

1. High corrosion-resistance against molten zinc or zinc alloys
2. Adjusted thermal expansion coefficients – No thermal shock damage
3. Low friction
4. Low adhesion to zinc/iron and zinc/iron/aluminum dross – No dross build-up
5. High surface hardness (950 HV)
6. No thickness and morphology change of the base material

The Boromet™ 144 coating is comparable to Teflon* for non-stick cookware, Boromet™ 144 is the vied as the Teflon* for industrial components. Boromet™ 144 coatings protect the base metal, including rolls used in galvanizing and aluminizing lines, die casting molds and in several other similar applications that involve molten metal. Boromet™ 144 coatings ensure that the molten metal does not damage or degrade the rolls, molds, and other components that are exposed to liquid metals during the galvanizing and other molten metal handling process. Metals also do not adhere to the coated parts, reducing clean-up time. Boromet™ 144 significantly extends the useful life of these components leading to considerable cost savings through reduction of early replacement, refurbishment, recoating, and maintenance expenses. Extended component life also results in tremendous savings in energy consumption while reducing production losses.

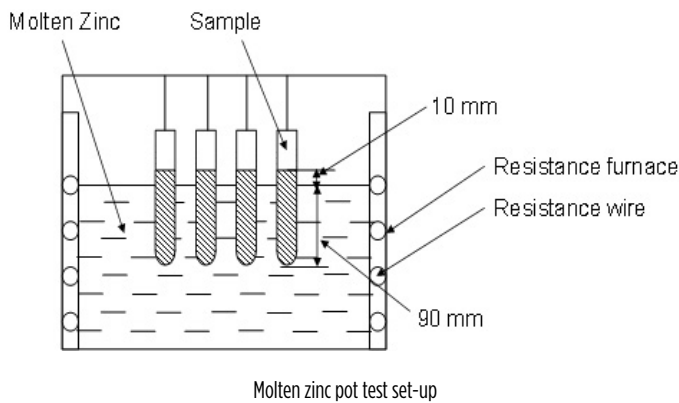
*Teflon® is a registered trademark of E. I. du Pont de Nemours and Company

Case Study

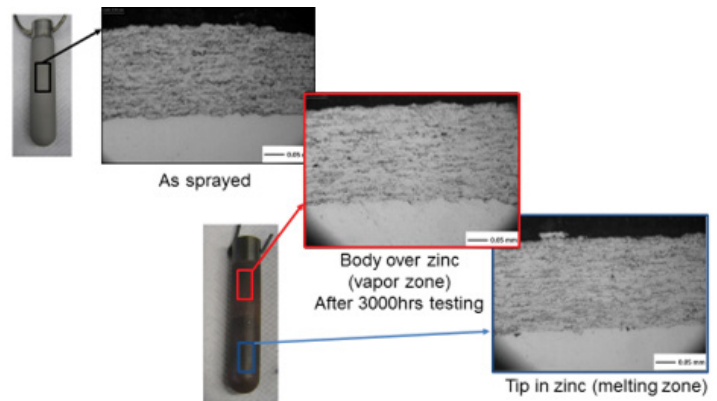
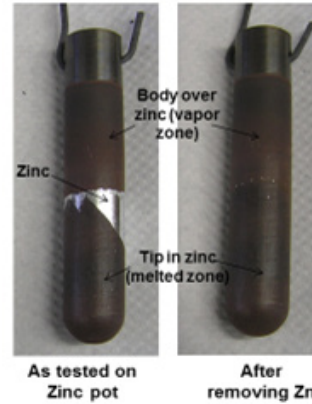
Hybrid Materials LLC has completed extensive in-house lab testing and field-testing to prove the supremacy of the Boromet™ 144 coatings compared to the current state-of-art moly-boride thermal spray powders from Fujimi, Nippon, etc. and the conventional tungsten carbide thermal spray powders.

Testing in Molten Zinc Pot

Hybrid Materials LLC tested its Boromet™ 144 coated pins in a molten zinc path, where the coated pins were removed from the molten bath every 24/48 hours, inspected, macro analyzed, cleaned and then immersed again if there was no damage. A schematic of the molten submersion rig test designed and used by Hybrid Materials LLC, Inc. is illustrated in the figure below.

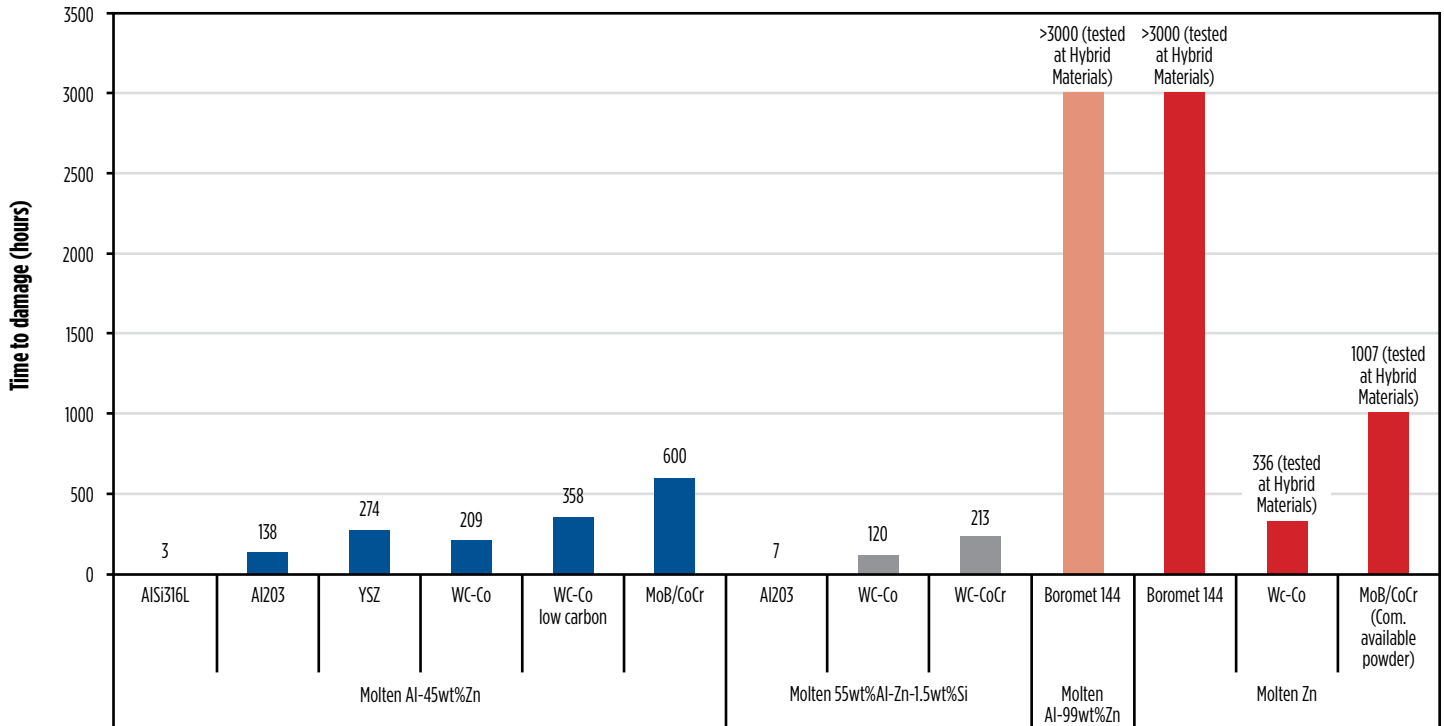


After 3,000 hours of testing there was absolutely no damage to the coatings and Hybrid Materials LLC chose to stop the testing since 3,000 hours was about 6 times longer than the current state-of-the-art moly-boride coatings.



Hybrid Materials LLC also compared Boromet™ 144 with the currently used alternatives to determine the time required to damage. The chart on page 3 are the results from this study.

Comparison of Boromet 144 with Currently-Used Alternatives



Field Testing

Hybrid Materials LLC has completed extensive field-testing of Boromet™ 144 coated pins in actual production environments. After two months testing, the coated pin samples showed not cross-build up and were easy to clean.



Other Applications

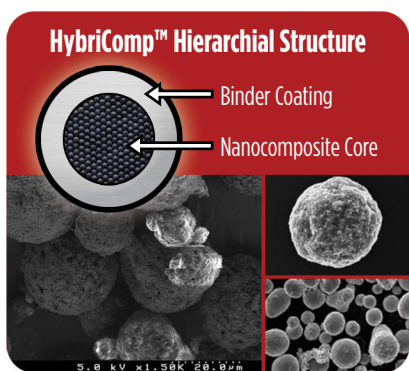
Boromet™ 144 coatings have several other applications in molten metal environments including galvanizing (sink rolls, correcting rolls, stabilize rolls), metal production (steel, aluminum), metal processing, metal forming, die casting, stamping, forging, etc. Below is an example of HybriComp-M coatings showing no damage after immersing in a molten steel environment.



After immersing in molten steel

About HybriComp Long-Life Thermal Spray Coatings

HybriComp thermal spray powders are the only thermal spray powders that lead to coatings that are both hard and tough, and hence despite the high hardness the coatings do not spall (flake) when bent. Additionally, Hybrid Materials LLC is the only company in the world that manufactures titanium nitride and silicon nitride based HybriComp thermal spray powders; despite decades of research no other company has been able to make titanium nitride and silicon nitride based powders that can be sprayed using thermal spray coating systems.



Near-Nano Composite Core

- High hardness and wear resistance
- Contains nano-dispersed friction modifiers
- Provides for fast machining

Binder Coating

- Improves adhesion and efficiency
- Provides toughness and resiliency
- Provides corrosion resistance
- Prevents compositional changes

HybriComp coatings are cermets fabricated into a hierarchical structure, developed with microstructures, engineered at the nano-, micro- and meso- scale, to offer revolutionary performance and cost breakthroughs. These materials are formed with a nano-composite core and binder coating by combining low friction, high wear resistance and excellent corrosion resistant materials. The nano-composite core provides high wear resistance, low friction and, for Titanium-Nitride and Silicone-Nitride based powders, light weight, while the binders provide corrosion resistance, toughness, ductility, resiliency, and improved deposition efficiency. This combination results in a high toughness, ductile-phased toughened structure comprised of high hardness tiles separated by ductile binder laminates.

Important to note is that HybriComp is a manufacturing methodology and not merely a product, with the HybriComp manufacturing methodology, Hybrid Materials LLC can combine a variety of materials that usually cannot be combined thus leading to best-in-class corrosion- and wear-protection. HybriComp cermet coatings can replace electrolytic hard chrome, electroplating, spray and fuse, and thermal spray carbides to impart wear and corrosion resistance, and reduce friction in sliding wear applications. HybriComp coatings are easy and fast to apply that can be machined to tight tolerances for dimensional restoration of OEM or worn E&P components. The HybriComp family of coating materials has been designed to act as a drop-in replacement for thermal spray powders and will work with today's existing application systems.

To learn more about our HybriComp coatings please contact us by phone at +1(216) 453-0866 or email at info@HybridMaterialsLLC.com.