

Q Our galvanizing bath has encountered some floating objects that look a little bit like dross. It often ends up on the product. What is this stuff?

The stuff is called floating dross. Dross inclusions can be a reason for rejecting the part and, therefore, should be treated as more than just an annoyance by galvanizers. Floating dross is not a subject that evokes black and white answers to the questions of formation, avoidance and solutions. Intuit observations and sound speculations are the main avenues for interpreting the floating dross phenomenon.

First of all, what is floating dross?

One type of floating dross is composed of suspended masses of long intermetallic spikes that are usually interwoven together in clumps. These clumps are found attached to the upper portions of the kettle wall or as the name indicates, floating as

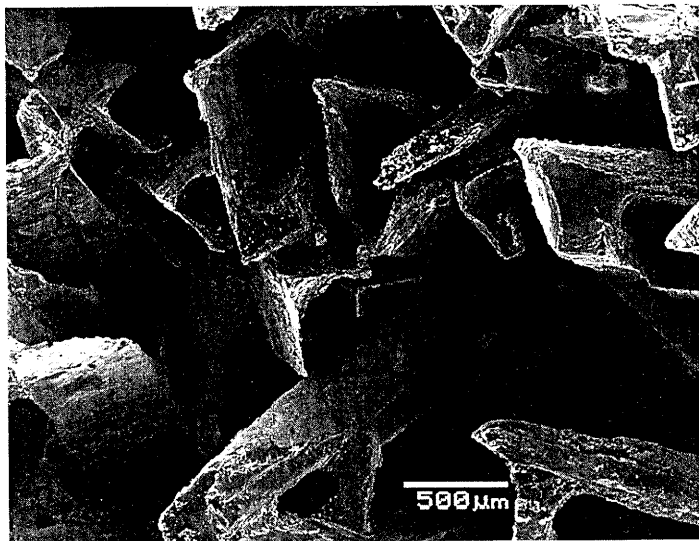


Figure 1

islands at or near the surface of the bath. When viewing the clumps under a high powered microscope (Figure 1) these spikes appear as needle-like crystals or straws.

Dross can become attached to the galvanized product and cause unsightly protrusions or pimples as shown in Figure 2. Bottom dross that is floating in the galvanizing bath, due to temperature inversions, may adhere to the surface of the part being galvanized. This dross becomes encapsulated in the free zinc (Zn) layer during withdrawal, causing excess

coating thickness and surface irregularity. ASTM A 123 states: "Galvanized articles shall be free from un-coated area, blister, flux deposits, and dross inclusions." The rejection of a product for dross inclusions, however, is rarely enforced.

How is floating dross formed? Am I causing the problem?

The formation of the floating clumps, i.e. dross, results as the iron (Fe) is rejected from the solution. Iron has a limited solubility in molten zinc. For example, at a temperature of 850 F the iron solubility is about 0.035% Fe. This means that any additional iron that enters the kettle above this value reacts with the molten zinc and falls to the bottom as dross. The introduction of loose iron particles may be from newly cleaned steel, fixtures, pickle salts, the kettle wall or temperature inversions that change the solubility level. This solubility correlation is temperature dependent and almost linear; as the temperature rises so does the solubility of iron.

Floating dross may occur when the surface regions of the galvanizing bath are colder than the deeper regions. In this case dross crystals separate out in the colder regions of the melt and remain floating in the bath or are deposited as pimples on the article being galvanized. The thermal discrepancy often occurs when the kettle is on "low-burn," possibly a holiday or weekend. Then, dross crystals can precipitate within the upper part of the bath and most commonly on the "cooler" upper wall of the kettle. When the burners are restored to "high-burn," these dross crystals can be transferred by convection currents into the operating section of the bath and picked up on the work as it is withdrawn.

The temperature gradient problem also may be influenced by wind chill of the surface of the bath which, as mentioned, leads to floating dross. That is, we know that the direction of energy transfer is always from the higher temperature body to the lower temperature one. This creates convection currents towards the top of the bath as the hot air evaporates to cool the surface while heat is transferred into the kettle nearer the bottom.

When viewing the microstructure (Figure 1) of the floating dross the long hollow spikes show up quite well. The elongated structure implies that there is growth across a temperature gradient. The density of the intermetallics is slightly heavier than liquid

zinc, and the elongated straw-like form of the inter-metallics probably helps them float to the top as opposed to sinking to the bottom like other dross particles.

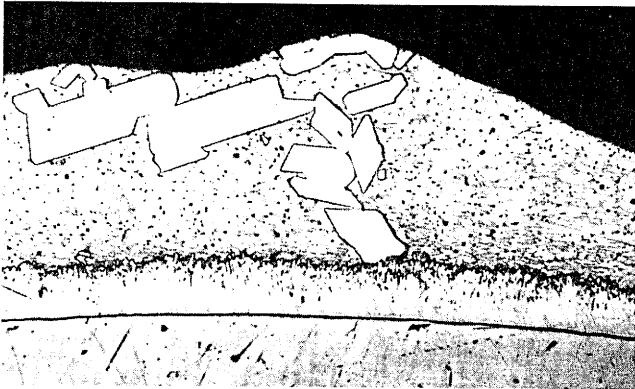


Figure 2

A further cause of floating dross can be unevenly distributed or high levels of aluminum (Al) or nickel (Ni). Bath element additions influence the formation of floating dross by changing the effective solubility of iron in zinc. At certain Ni levels in the bath, two types of dross co-exist: floating dross and bottom dross. The floating dross consumes a lot of Ni and can reduce the operating efficiency of the bath.

Bath addition management that allows abundant Ni level oscillations can produce floating dross. Adding small amounts of Ni as a daily practice helps to maintain a nearly constant Ni level, whereas a once-a-week addition tends to allow the Ni level to drop well below recommended levels.

When Ni is added to the bath, the Fe solubility in zinc is reduced. If the bath is saturated in Fe, the excess Fe will precipitate out of solution and combine with Zn and Ni to form dross, which will float in the bath and cause problems until it settles to the bottom of the kettle. Kettle size, geometry, the type of firing system, burner locations, and flue-gas paths all affect the solubility of iron in zinc.

It has been stated that floating dross is rarely observed with zinc-nickel baths, it is – on the contrary – very frequently present in zinc-aluminum baths. In reality, both aluminum and nickel help iron precipitate out of solution to cause floating dross. These element additions are considered a more controllable variable when compared to temperature differentials.

I now know what this stuff is and how it is formed. But how do I solve this floating dross problem?

The reduction of dross formation can be accomplished by minimizing loose iron particles in the bath, maintaining upper wall temperature, and maintaining bath addition levels. Temperature differentials within the bath are the most likely culprit to causing the unwanted floating dross. This requires that the kettle either be run on high-burn continuously to maintain the constant temperature on the top part of the bath or deal with the floating particles by repeated drossing and skimming after periods of bath inactivity.

Most publications and research describe bottom dross while completely disregarding the zinc-iron clusters known as floating dross. Consequently, no concrete solutions are available for floating dross. There are, however, several urban legends or theories of how to rid the bath of the floating dross, once its presence is discovered.

Thoughts are that the addition of nitrogen in the zinc bath will cause the floating dross to go away. Bubbling nitrogen directly into the bath is one method. Potatoes have been boiled and the release of nitrogen contained in them is believed to help. (This may also create a turnkey french-fry style business run out of your plant.) In extreme cases the addition of lead to a SHG or HG bath has been used to eliminate the floating dross.

Besides taking the precautionary steps to avoid the formation of the floating dross, the best solution may be to wait for it to settle down to the bottom or to run product that is only marginally affected by floating dross on the part.