The resulting galvanized coating is tough and durable, comprising relatively pure zinc and zinc-iron alloy layers bonded metallurgically to the underlying steel, completely covering the article and providing unmatched resistance to abrasion.

An important advantage of the galvanizing process is that visual inspection shows that work is completely protected and gives an excellent guide to coating quality. Inspection of galvanized products is detailed on page 42. Standards covering galvanized coating thickness and quality are listed on page 42.

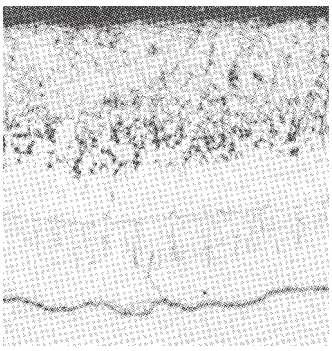
Galvanizing fasteners and small components

Fasteners and small components are loaded into perforated cylindrical steel baskets. After acid pickling and prefluxing, baskets are lowered into the galvanizing bath. On withdrawal from the molten zinc, baskets are raised without delay into a centrifuge or 'spinner' and rotated at high speed for 15 to 20 seconds. Excess zinc is thrown off, providing a smooth, uniform coating.(See also page 47.)

Metallurgy of galvanizing

When the cleaned and fluxed steel surface contacts the molten zinc of the galvanizing bath the protective flux layer is removed leaving a clean steel surface which is immediately wetted by the zinc. This results in reaction between zinc and steel with the formation of zinc-iron alloy layers.

The photomicrograph below shows a section of a typical galvanized coating which consists of a progression of zinc-iron alloy layers bonded metallurgically to the base steel, with the relatively pure outer zinc layer.



Eta layer. Relatively pure outer zinc coating

Zeta layer. Zinc-iron alloy containing 5.8 to 6.2% iron

Delta layer. Zinc-iron alloy containing 7 to 12% iron

Gamma layer. Thin molecular layer containing 21 to 28% iron

Base steel

Abrasion resistance of galvanized coatings

The photomicrograph below shows that the delta and zeta zinc-iron alloy layers are actually harder than the base steel, resulting in galvanizing's outstanding resistance to abrasion and mechanical damage. Abrasive or heavy loading conditions in service may remove the relatively soft eta layer of zinc from a galvanized surface, but the very hard zeta alloy layer is then exposed to resist further abrasion and heavy loading.

Eta layer
70 DPN hardness

Zeta layer
179 DPN hardness

Delta layer
244 DPN hardness

Base steel
159 DPN hardness

Coating thickness

During the first minute of immersion in the galvanizing bath zinc-iron alloy layers grow rapidly on the surface of the steels which are most commonly galvanized. The rate of alloy layer growth then diminishes and is finally very slow. When the work is withdrawn from the bath an outer layer of relatively pure zinc is also carried out. The total zinc coating mass applied depends mainly on the mass and thickness of the steel being galvanized.

AS/NZS 4680 specifies the following minimum average coating thicknesses.

Table 1

Requirements for coating thickness and mass for articles that are not centrifuged

Steel Thickness mm	Local coating thickness minimum µm	Average coating thickness minimum µm	Average coating mass minimum g/m²
≤1.5	35	45	320
>1.5 ≤3	45	55	390
>3 ≤6	55	70	500
>6	70	85	600

Note: 1 g/m² coating mass = 0.14 µm coating thickness.

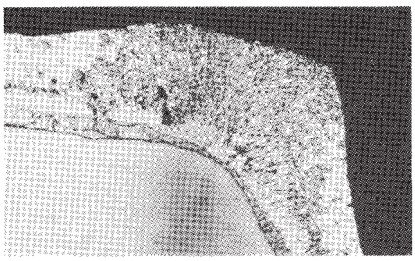
Table 2

Requirements for coating thickness and mass for articles that are centrifuged

Thickness of articles (all components including castings) mm	Local coating thickness minimum µm	Average coating thickness minimum µm	Average coating mass minimum g/m²
<8	25	35	250
≥8	40	55	390

Notes:
1. For requirements for threaded fasteners refer to AS 1214.
2. 1 g/m² coating mass = 0.14 µm coating thickness.

As indicated the total coating mass on heavier steel sections normally contains a minimum of 600 grams of zinc per square metre of surface area, (g/m²) equivalent to about 85 µm thickness. As illustrated below, coating thickness is slightly greater at corners.



Galvanized coatings are slightly thicker at corners and edges as shown, an important advantage over most organic coatings which thin out in these critical areas.

The structure of the galvanized coating and the relative thickness of its zinc-iron alloy layers have little or no effect on the protective life of the coating. Protective life depends basically on total coating mass as discussed on page 19.

On most commonly galvanized steels, the relatively pure outer zinc layer of the galvanized coating solidifies to give the typical bright zinc crystal or 'spangle' finish. Certain steel compositions may cause the zinc-iron alloy layer to grow through to the surface of the galvanized coating producing a matt grey finish sometimes known as 'grey bar', as discussed below under 'Composition of steel' and on page 42 under "Dull grey coating". There is negligible difference between the protective lives provided by either coating.