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6 March 1936

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March 6, 1936

Preliminary Heat Treatment
of
Chromium Plated Steel

Four specimens of chromium plated black pipe* were submitted by Dr. Kesting to ascertain the quality, tendency to crack, and alloying of the plate. Two specimens had a thin layer plate and two had a thick layer plate. One of the thick layer specimens had been heat treated; the other three were in the "as plated" condition.

Conclusions

1. The thin layer specimens showed many spots where the plating had not adhered. The spots showed up as spongy or porous areas. There were places where the plate showed signs of exfoliation. There were also many more or less radial cracks. Such conditions would afford little corrosion resistance.

2. The thick layer specimens (as plated) showed many long and short cracks in the plate. These cracks ran from the steel outward far into the plate; others started and

finished entirely in the plate. Most of the cracks occurred in the inner third of the plate thickness; in this zone there was little porosity. The porosity increased toward the outside.

3. The heat-treated specimen showed considerable alloying, especially along grain boundaries. No cracks were found, but numerous irregular and discontinuous, narrow films of (probably) chromium oxide were found in locations similar to the cracks in the nonheat-treated specimen. The inner 2/3 of the plate thickness showed little porosity. The outer 1/3 was badly oxidized. The oxides appeared as cubic crystals along the grain boundaries and scattered about. Good corrosion resistance should be expected if the outer 1/3 was removed.

Note: It is difficult to determine whether the above mentioned porosity was really porosity due to plating technique or pitting due to polishing.

Heat Treatment

Heated to 1150°C, held 8 hours, furnace cooled.

Experimental

Fig. 1 X100 FCr 1 Shows the plating to be discontinuous.
ME 400

Figs. 2 & 3 X1000 F Cr 1 Show areas of expoliation of
the plate. ME 401, 402

Fig. 4 X100 F Cr 2 Shows the plating to be discontinuous.
ME 403

Figs. 5 & 6 X1000 F Cr 2 Show areas where plating did
not adhere. ME 404, 405

Fig. 7 X100 F Cr 5 Shows cracking in the thick plate
near the steel. ME 406

Figs. 8 & 9 X1000 F Cr 5 Show cracks in the plate near
the steel. ME 407, 408

Fig. 10 X100 F Cr 5H Shows no cracking of the plate,
considerable alloying with the
steel especially along grain
boundaries. ME 409

Figs. 11 & 12 X1000 F Cr 5H Show that chromium is al-
loying with the steel as a wave
in addition to the grain boundary
method. No cracks were found in
the plate, but an oxide film was
found in a similar location to the
cracks in the nonheat-treated plate.
ME 410, 411

Fig. 13 X1000 F Cr 5H Shows that the outer zone of the
plate was badly oxidized. The
oxides occur as cubic crystals
located in the grain boundaries
and scattered throughout the grains.
ME 412

Respectfully submitted,

H. G. Carter

* Plating Data

F Cr 1 -

Plated 3.8 v., 1 amp/sq.in., Temperature Bath 103°F,
plated 1 hour, high sulfate bath.

F Cr 2 -

Plated 7 v., 3 amp/sq.in., Temperature Bath 105°F,
plated 1 1/2 hours, high sulfate bath.

F Cr 5 -

Plated 5.6 v., 3 amp/sq.in., Temperature Bath 113°F,
plated 10 3/4 hours, standard bath.

F Cr 5H -

Same as F Cr 5, reheated to 1150°C, plated 8 hours,
furnace cooled.

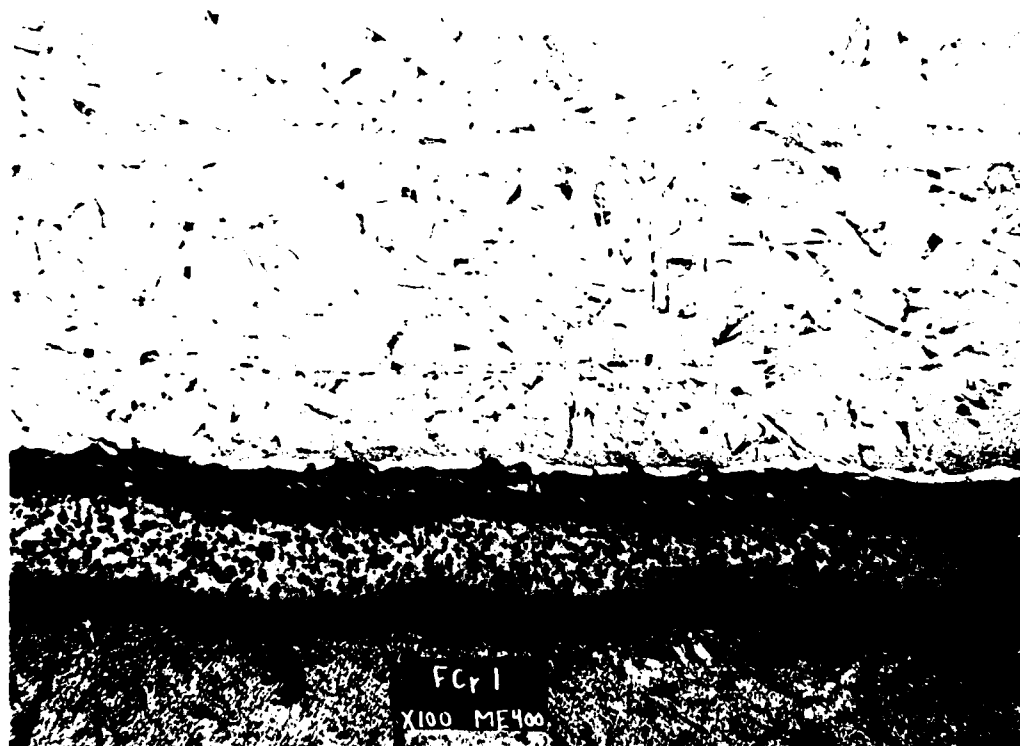
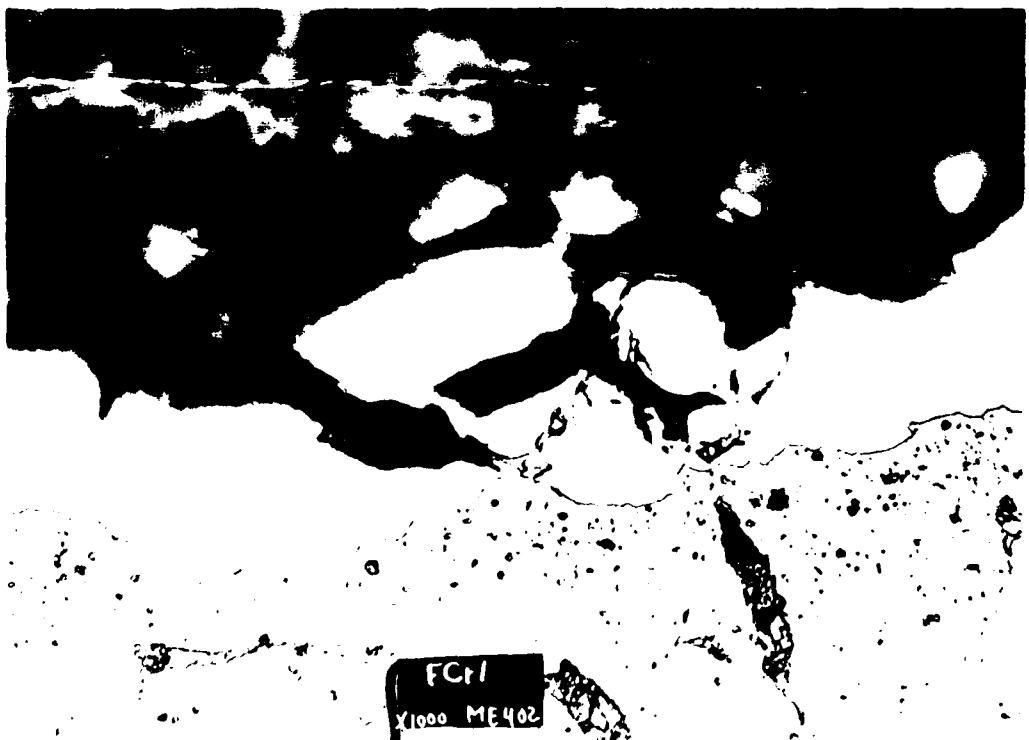


FIG. 1



FCr1
X1000 ME401

FIG. 2

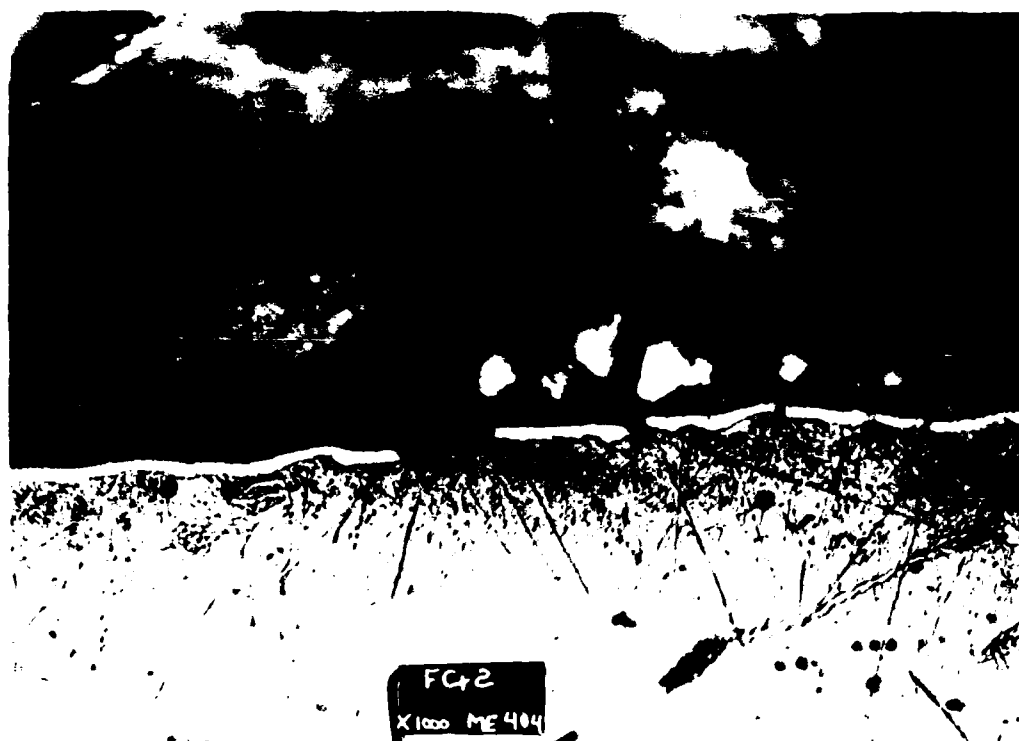


FCr1
X1000 ME402

FIG. 3



FIG. 4



FC+2
X1000 ME404

FIG. 5



FC+2
X1000 ME405

FIG. 6

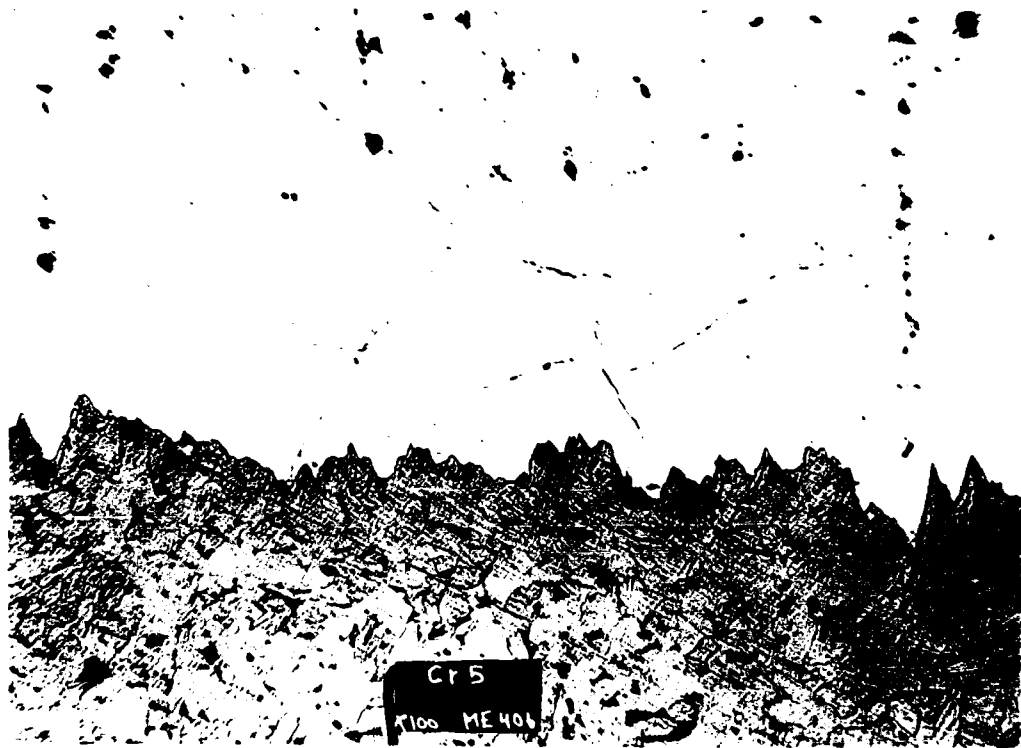


FIG. 7

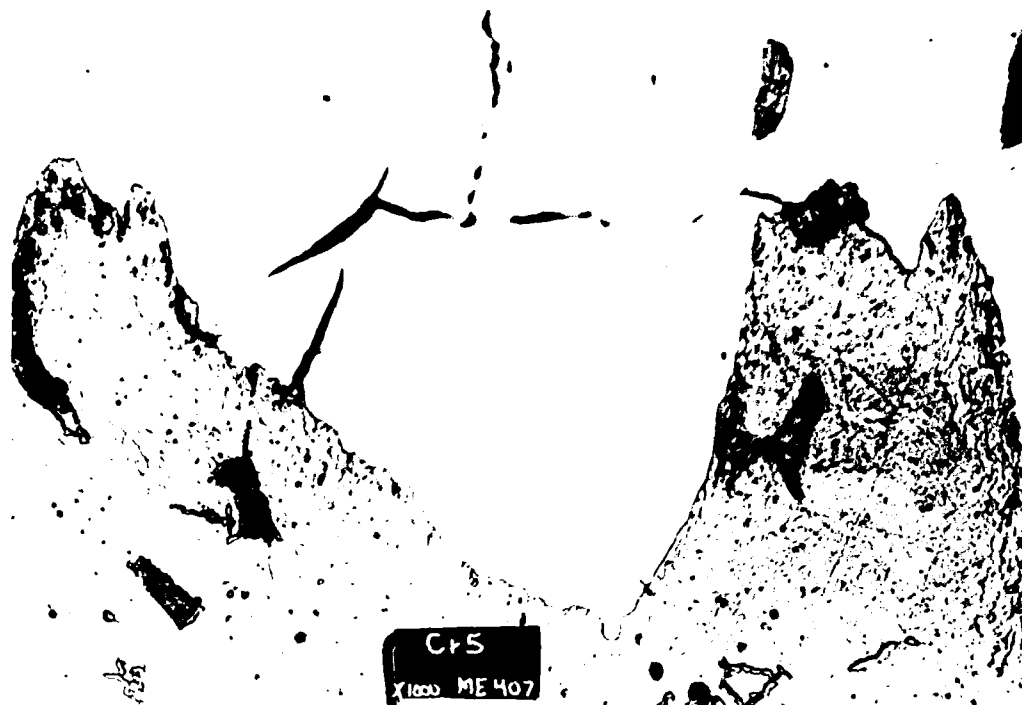


FIG. 8

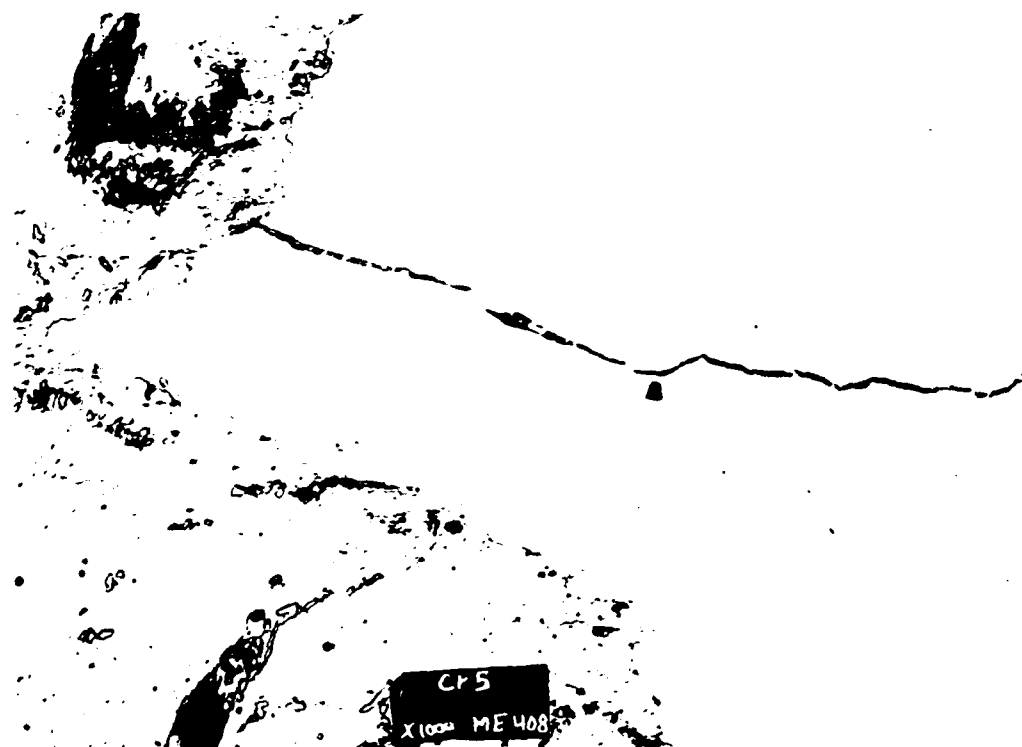


FIG. 9



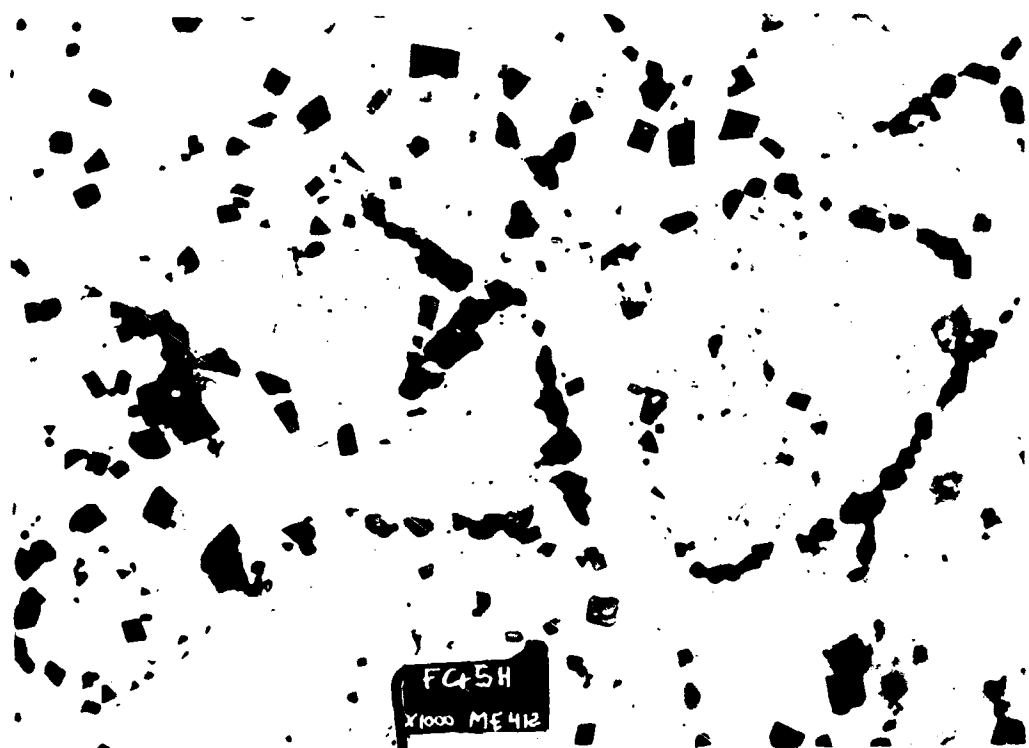
FIG. 10

FCr5H
X1000 ME410

FIG. 11

FCr5H
X1000 ME411

FIG. 12



FC45H
X1000 ME412

FIG. 13