

DEPARTMENT OF ENGINEERING RESEARCH

UNIVERSITY OF MICHIGAN

ANN ARBOR

Report

on

METALLOGRAPHIC EXAMINATION OF SILVER-NICKEL-IRON AND
SILVER-IRON-NICKEL TRIMETALS

by

J. W. Freeman
J. W. Freeman

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METALLOGRAPHIC EXAMINATION OF SILVER-NICKEL-IRON AND SILVER-IRON-NICKEL TRIMETALS

This report presents photomicrographs of the structures of silver-nickel-Armco iron and silver-Armco iron-nickel trimetals. Typical examples of the type of bond between the layers of metals and the structures of all the samples are shown.

CONCLUSIONS

The information obtained from the metallographic examination may be summarized as follows:

1. With the exception of one sample, the bond between the silver and nickel appeared to be better than between the silver and Armco iron.
2. In all cases the bond between the nickel and Armco iron appeared to be superior to the silver bonds. Actual alloying between the two materials took place.
3. The bond between the silver and the other materials appeared to be mechanical in nature rather than by an alloying effect.
4. The two samples of silver-Armco iron-nickel trimetal which were supposed to have been annealed at 1600°F. apparently had not been heat treated.

MATERIALS INVESTIGATED

Seven samples of nickel-Armco iron bimetal with the nickel side silver faced and seven samples with the Armco iron side faced with silver were submitted. Each specimen was approximately one half inch square. These samples and their treatment, as indicated in a letter from Mr. S. R. Hood on February 20, 1942, are given in the following tabulation:

<u>Sample Number</u>	<u>Type Material</u>	<u>Treatment</u>
1	Silver-Nickel-Armco Iron	As Cast
2	" " " "	Rolled 50% Reduction
3	" " " "	Rolled 50% Reduction, Ann. 1600°F.
4	" " " "	Rolled 50% Reduction, Ann. 1200°F.
5	" " " "	Rolled 82% Reduction
6	" " " "	Rolled 82% Reduction, Ann. 1600°F.
7	" " " "	Rolled 82% Reduction, Ann. 1200°F.
8	Silver-Armco Iron-Nickel	As Cast
9	" " " "	Rolled 50% Reduction
10	" " " "	Rolled 50% Reduction, Ann. 1600°F.
11	" " " "	Rolled 50% Reduction, Ann. 1200°F.
12	" " " "	Rolled 82% Reduction
13	" " " "	Rolled 82% Reduction, Ann. 1600°F.
14	" " " "	Rolled 82% Reduction, Ann. 1200°F.

PROCEDURE

The metallographic examination was conducted by cutting the small squares into two or three pieces and mounting them side by side in bakelite. The polishing procedure consisted of grinding through successive grades of metallographic paper by hand, and then on three cloth covered wheels containing successively fine grades of abrasive. Final polishing was carried out with magnesium oxide on a silk broadcloth covered wheel.

It was found necessary to etch and repolish on the final wheel several times to reveal the structures essentially free from polishing cold work. This latter procedure was especially true of the silver. The silver was etched with a dichromate-chromic acid solution, the Armco iron with 4 per cent nitric acid in alcohol, and the nickel with a 50 per cent HNO_3 - 50 per cent acetic acid solution.

RESULTS

The photomicrographs taken are shown in Charts 1 through 7. The bonds between the various layers were examined before etching the samples. Charts 1, 4 and 5 show typical photomicrographs at 500X. In so far as was observed photomicrographs 1a and 1b were typical of the unetched appearance of the silver-nickel and nickel-Armco iron bonds, with the exception of sample 6. Apparently the silver had separated from the nickel in the 82 per cent reduced samples annealed at 1600°F., as is shown in Chart 4.

The samples were then subjected to the etching and repolishing procedure until the structure was clearly revealed. Typical photomicrographs of the bonds in the "as cast" samples are shown in Charts 1 and 5. Similar photomicrographs of the 50 per cent reduction samples annealed at 1200°F. are shown in Charts 3 and 6.

The other charts show the structures of the samples in the etched condition at X100D magnification.

DISCUSSION OF RESULTS

The bond between the nickel and the silver appeared to be better than the silver-Armco iron. Apparently the surface of the nickel was rough and allowed fingers of silver to penetrate into the surface as shown in the photomicrographs of Chart 1. The silver-Armco iron bond appeared as a straight line very similar to that which would be obtained when two metals were pressed together. The nickel-Armco iron bond showed the presence of a diffusion layer and could only be observed by a difference in color of the two metals with no line of demarcation visible. The line of demarcation between the silver and the other two metals was visible in all cases.

During the etching and repolishing operations it was impossible to avoid the development of a difference in level between the various layers. This was caused by more of one material being removed during polishing and etching. Therefore in many cases the bonds appeared worse than they actually were.

During the mounting operation bakelite did not penetrate between the sections of the samples. In the grinding operations the silver "burred" over into this empty space. Therefore the photomicrographs do not show a clean line of demarcation.

Numerous inclusions were present in the Armco iron. In some cases it was impossible to prevent their removal resulting in a pitted surface. Numerous holes were present in the silver layers in the as cast condition. This was particularly true of the silver in Samples 1 through 7. The silver was also very coarse grained in the as cast condition.

Attention is also called to the strained appearance of Samples 10 and 13 which were supposed to have been annealed at 1600°F.

The only evidence of separation of the silver layer was found in Sample Number 6 as shown in Photomicrographs (b) and (c) of Chart 4.

