DMC nobelclad GROUPE SNPE

NT 306

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Electrical Resistance of Transition Joints for Reduction Cells

Introduction

Aluminum-steel electric transition joints (ETJ) are used in aluminum and magnesium reduction cells for making welded connections between aluminum buss systems and steel anodes and cathodes. Depending upon the cell design and operating procedures, transition joints can operate at temperatures ranging between 200° C and 500°C, and sometimes hotter.

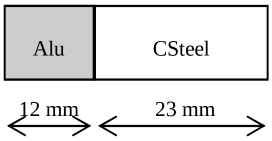
Minimizing electrical resistance is a significant aspect of cell design. As a component of the system, it is imperative that the transition joints have lowest electrical resistance throughout their service lifetime. The electrical resistance of a clad and its electrical stability over time are very dependent upon the materials of construction of the joint and the manufacturing method. **Nobelclad's ETJ Biclad and ETJ2000** are manufactured by explosion welding. The explosion welded products exhibit resistance which is equal to the sum of their components in series; the explosion bond does not contribute any measurable additional electrical resistance. ETJ2000 has been specifically designed to maintain its low initial electrical resistance over extended periods of very hot service experience and is unequalled by any other joint available. In comparison, products manufactured by roll bonding exhibit higher initial resistances and significantly lower thermal stability in hot service applications.

Electrical Resistance of ETJ

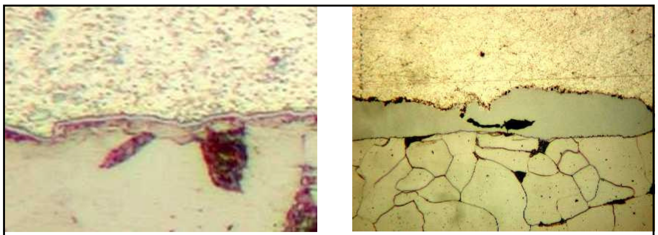
Electrical Resitance (microOhm)			
	ETJ Biclad	ETJ 2000	Roll-bond clad
As manufactured	38.8	44.2	55.8
After 24 hours at 375°C (700°F)	39.5	44.2	56.0
After 195 hours at 375°C (700°F)	40.4	44.2	56.0
After 24 hours at 500°C (930°F)	N.A.	44.2	57.2
After 125hours at 500°C (930°F)	N.A.	44.2	177.5
After 275 hours at 500°C (930°F)	N.A.	44.2	11 250.0

Accuracy of measurement ± 0.03 %

The measurement is performed on machined cylinder 35mm long and 10 mm in diameter.

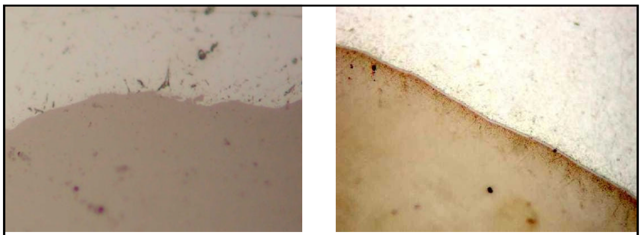


Sefelec micro-ohmmeter MGR10 is used with statistical processing of ten repeated measurements. A constant current (1-10 amp) is applied across the samples through one pair of probes. At the same time, an other pair of probes is used for measurement.



As- Manufactured 165 hours at 490°C

Roll-bonded clad (x500)



As- Manufactured 165 hours at 490°C

ETJ 2000 (x500)

In the “as-manufactured” condition, both products exhibit a clean interface between the aluminum and the adjacent metal. A 2 micron thick chrome layer is clearly visible in the roll-bonded product. The steel microstructure of this product indicates relatively high carbon levels as well. Both of these features contribute to higher electrical resistance of the roll-bond product in the as-manufactured" condition, as shown above.

The second set of photomicrographs are taken after exposing the samples at 165 hours at 490°C. A 20-micron thick intermetallic layer has formed at the bond of the roll-bond sample. Spectrographic examination indicates that this layer is $FeAl_3$, an intermetallic with high electrical resistivity. As shown above, the increase in electrical resistance is enormous. In contrast, the ETJ2000 sample exhibits a nearly clean interface, with the formation of a titanium-aluminum intermetallic layer about 1-micron thick. As shown in the table, there is no measurable change in electrical resistance. Tensile strength data on the two products show similar changes, ETJ2000 exhibits minimal change in strength after 165 hours at 490°C while the roll-bonded samples exhibited total loss of bond strength.

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