



Analysis results of explosion-bonded titanium to stainless steel plate using a nickel interlayer

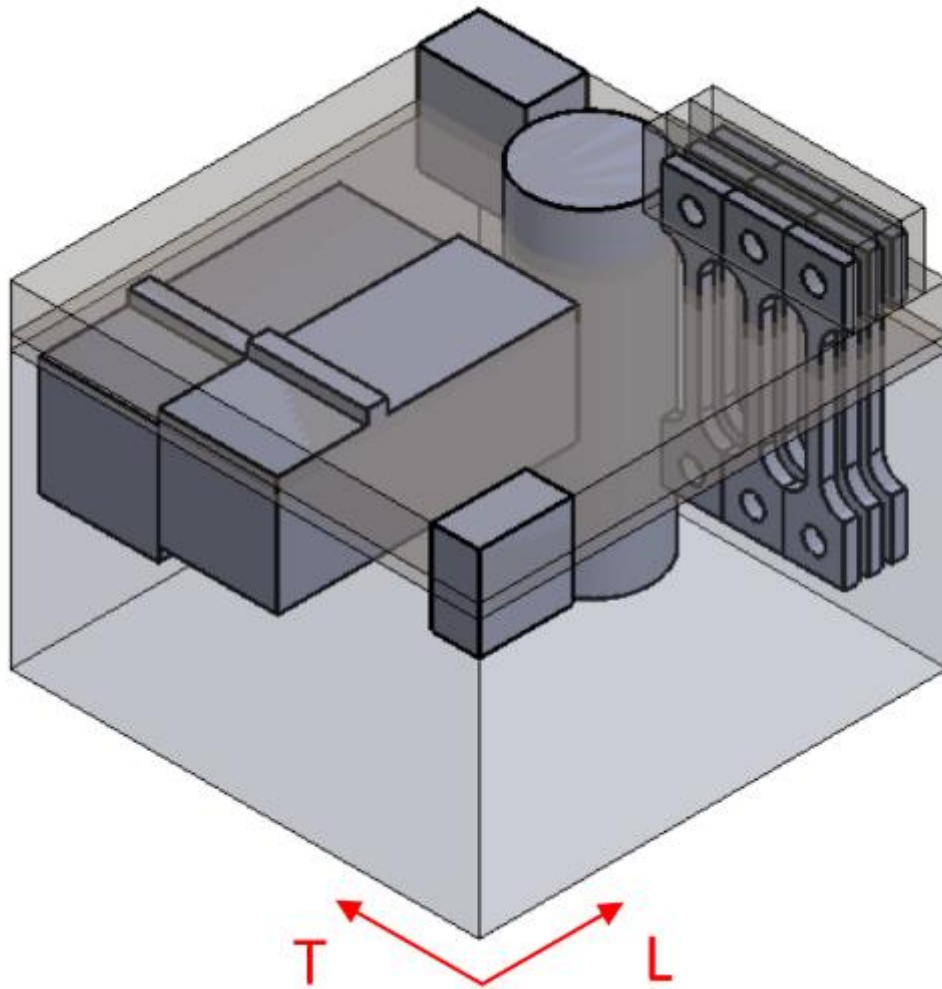
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Introduction

- A Ti-Ni-SS explosion-bonded block has been received (Nobelclad, FR) to validate this type of bonding in an initial test (sample was a left-over)
- Brittle phases were identified in metallography (presentation P. Fernandez Pison, 01.02.2016, EDMS 1705993), showing voids and questioning the applicability of the joint
- The current analysis contains
 - Leak tightness test
 - Shear tests

Specimen extraction



- 2 metallographic samples
- 9 tensile samples
- 3 shear samples
- 1 leak-tightness sample

Metallurgy: Ti – Ni interface

L-direction

T-direction



TiNi_3 – brittle intermetallic

Leak tightness test

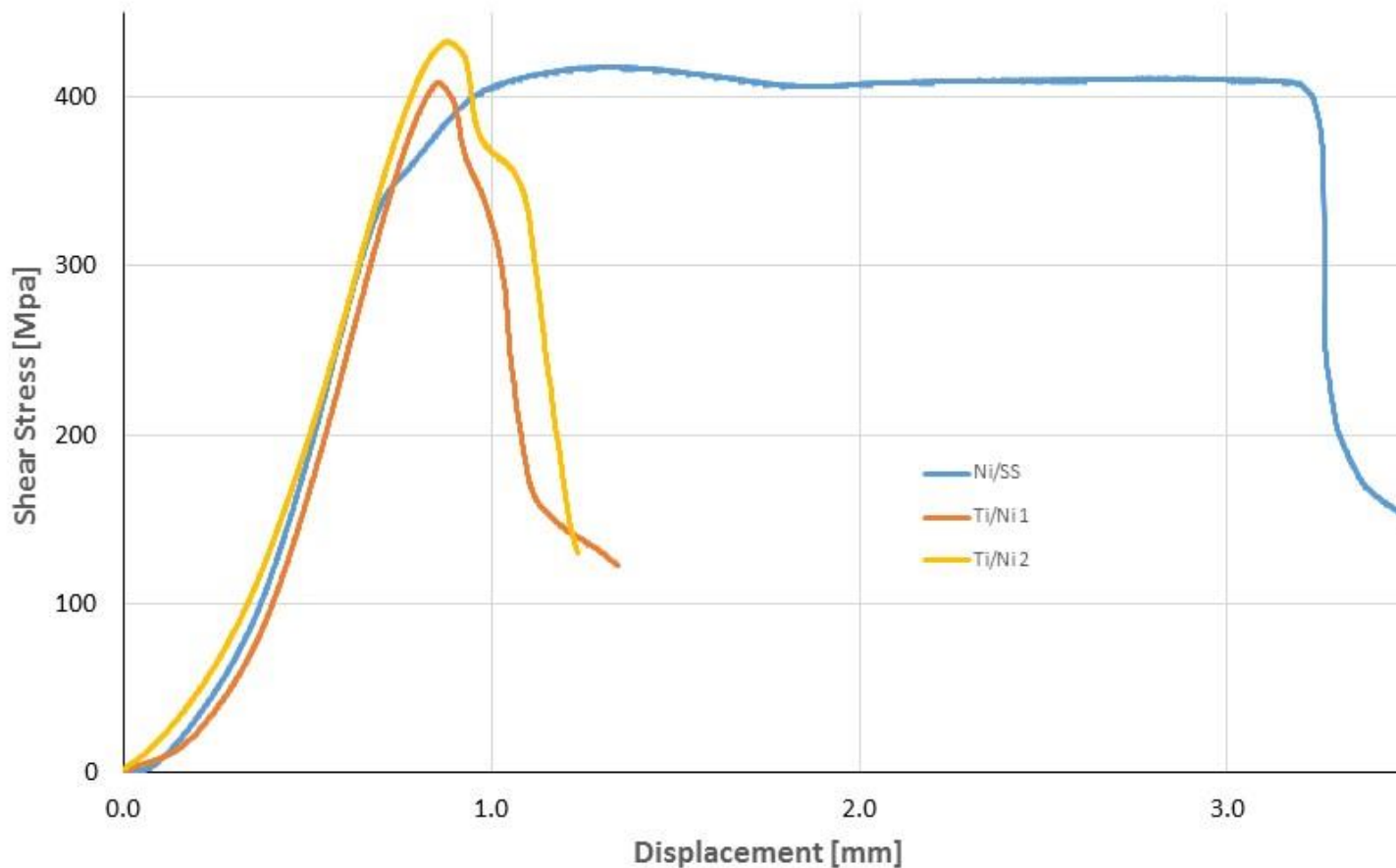
- Sample is connected to a pump with helium detector and brought under vacuum
- He probe is used to locally determine leaks
- Max. allowable leak rate is $2 \cdot 10^{-11}$ Pa m³/s (CCCM Engineering Specifications)

Result:

Leak of $1.3 \cdot 10^{-6}$ Pa m³/s



Shear test



Even though shear strength in either interface is fairly high, the TiNi_3 phase present in the interface leads to a brittle behaviour of the Ti/Ni interface

Conclusion and Outlook

- This specific explosion-bonded joint, containing a nickel interlayer, does not qualify
- The intermetallics observed in the interface appear to cause the problem (both mechanically as well as in terms of voids)
- Steel used was duplex steel 318LN (1.4462), which has a higher hardness (≤ 270 HB) than 316L (≤ 215 HB)
- Hardness influences the energy transfer during the explosion bonding → higher hardness can lead to formation of intermetallics
- Intermetallics may also be formed by subsequent heat-inducing processes (i.e. welding)

Outlook

- Full report will be available in [EDMS 1705993](#)
- Further tests will be done using
 - Cu interlayer (currently at workshop for sampling)
 - Ta interlayer (had been successfully tested at Fermilab)
- ➔ Both with 316L base and Ti-Gr1 cladding material