Brazing of Nickel Superalloys

- Ni – 3.5% Si – 1.9% B is:

National	Manufacturer	User
BS-1845 HTN4	Nicrobraz 135	MSRR 9500/700
AWS BNi-4	Amdry 790	DMR 35/304
AMS 4779	Niflex 79	

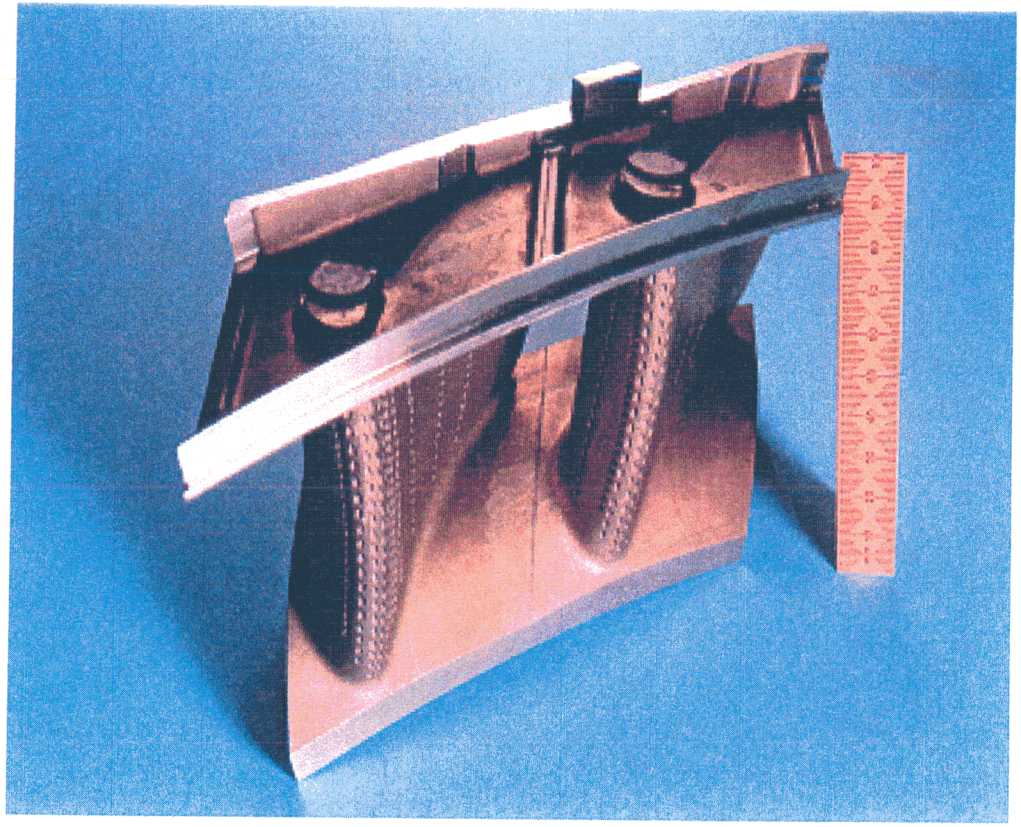
- etc.

Brazing of Nickel Superalloys

- Welding or Brazing?

For welding:	For brazing:
Stronger	No cracking in substrate
Quicker to do	Many joints at once
Only local changes to substrate	Solves problems of access to joint
Dissimilar-metal joining is easier	Less distortion of component

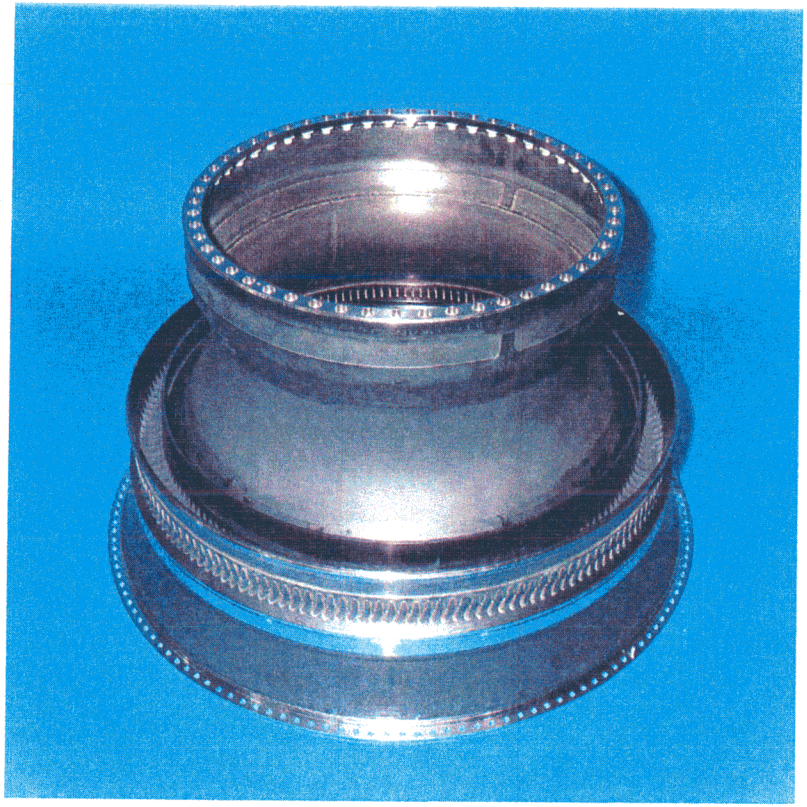
Brazing of Nickel Superalloys

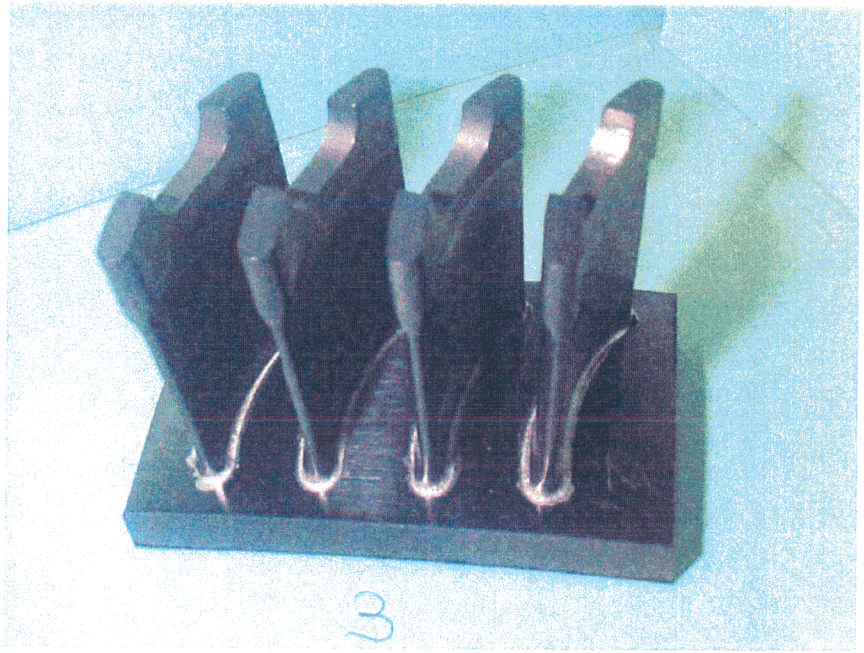


Pair of Nozzle Guide Vanes

(MAR-M002 vanes, HTN 1A braze)

Brazing of Nickel Superalloys

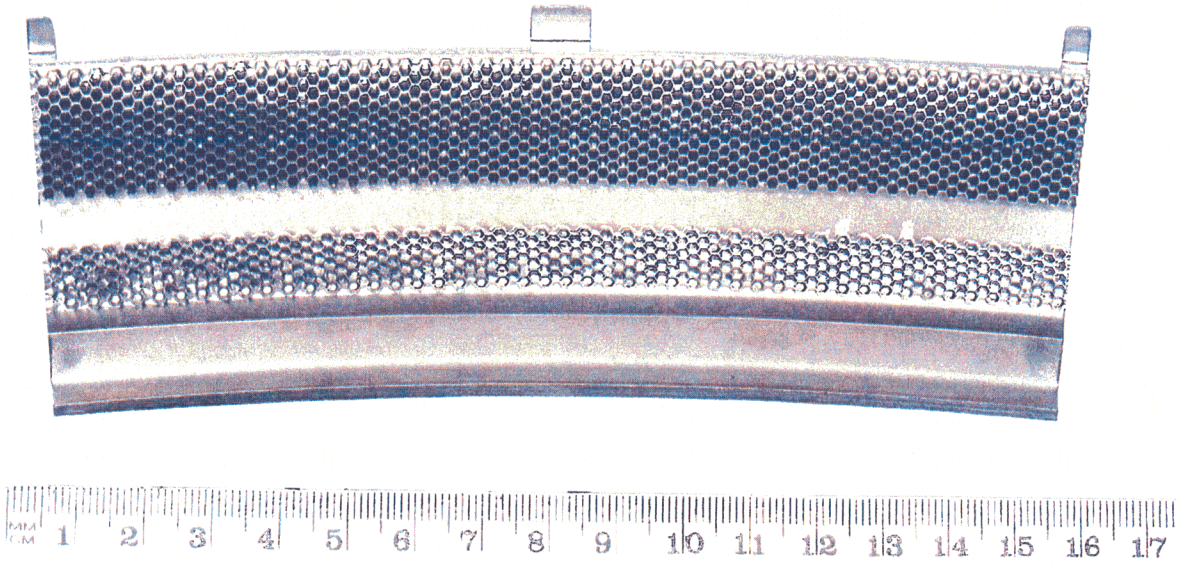




Tay Engine, HP Compressor Outlet Guide Vanes

(Nimonic 105 vanes, PE16 ring, HTN4 braze)

Brazing of Nickel Superalloys



Honeycomb Turbine Seal

Haynes 214 foil on C1023 backing plate

Brazing of Nickel Superalloys

Hole Closure on Turbine Blades

Single crystal CMSX4 or RR3000 blades, was HTN1A braze tape, now welded.

Brazing of Nickel Superalloys

- Eutectic systems :

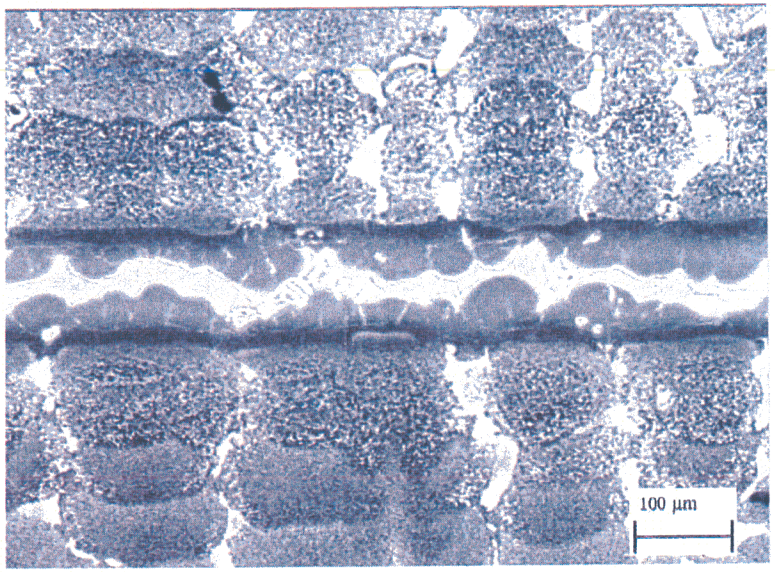
• Ni – P	Min. melting point	870°C
• (Ni – Ti	"	942°C)
• Ni – Si	"	964°C
• Ni – B	"	1018°C
• Ni – Hf	"	1150°C

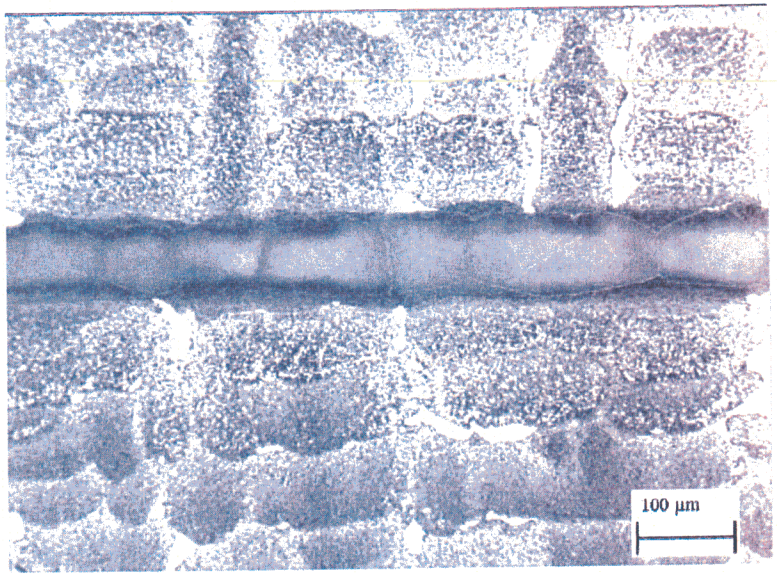
Brazing of Nickel Superalloys

- Typical Compositions, weight % :

System	A Trade Name	Cr	Si	B	Fe	Others
Electroless Ni	-					5-10 P
Ni-Cr-B	Niflex 95	15		3.5		
Ni-Si-B	Nicrobraz 135		3.5	1.9		
Ni-Cr-Fe-Si-B	Amdry 915	13	4.5	3	4	
Ni-Cr-Fe-W-Si-B	Nicrobraz 171	10	3.5	2.5	3.5	12W, 0.4C
Superalloy + B	Niflex 110	10		~2		4W, 5Co, 2Al, 4Ta

Brazing of Nickel Superalloys

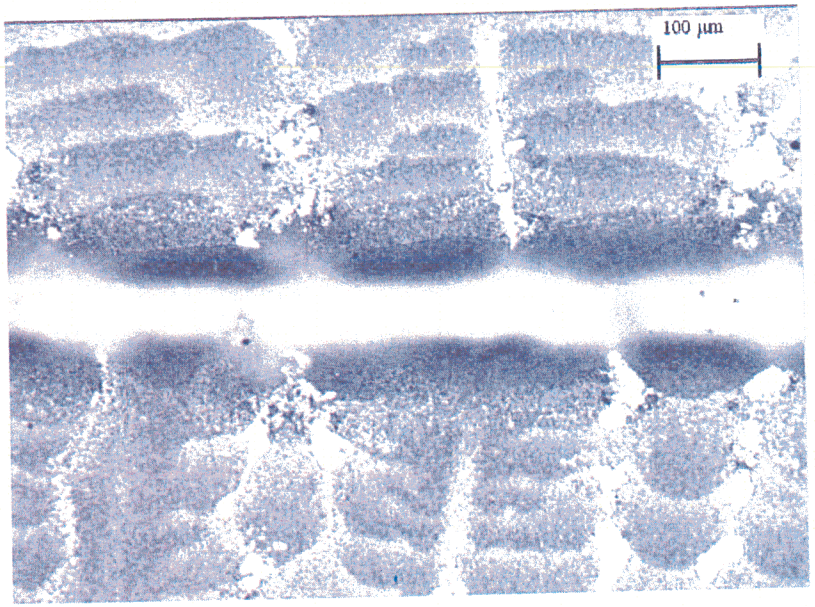


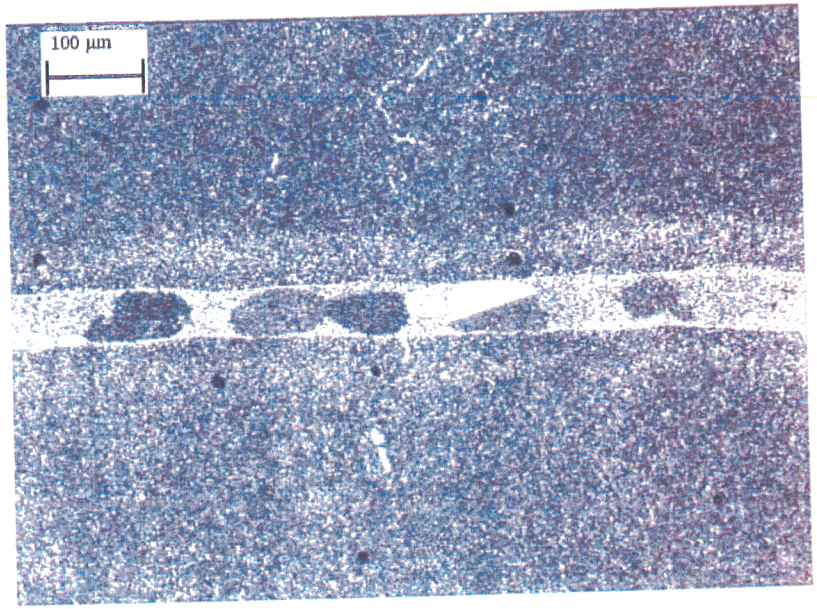


Undissolved borides in thick joint; no borides in thinner one

As cast CMSX4, experimental braze

Brazing of Nickel Superalloys



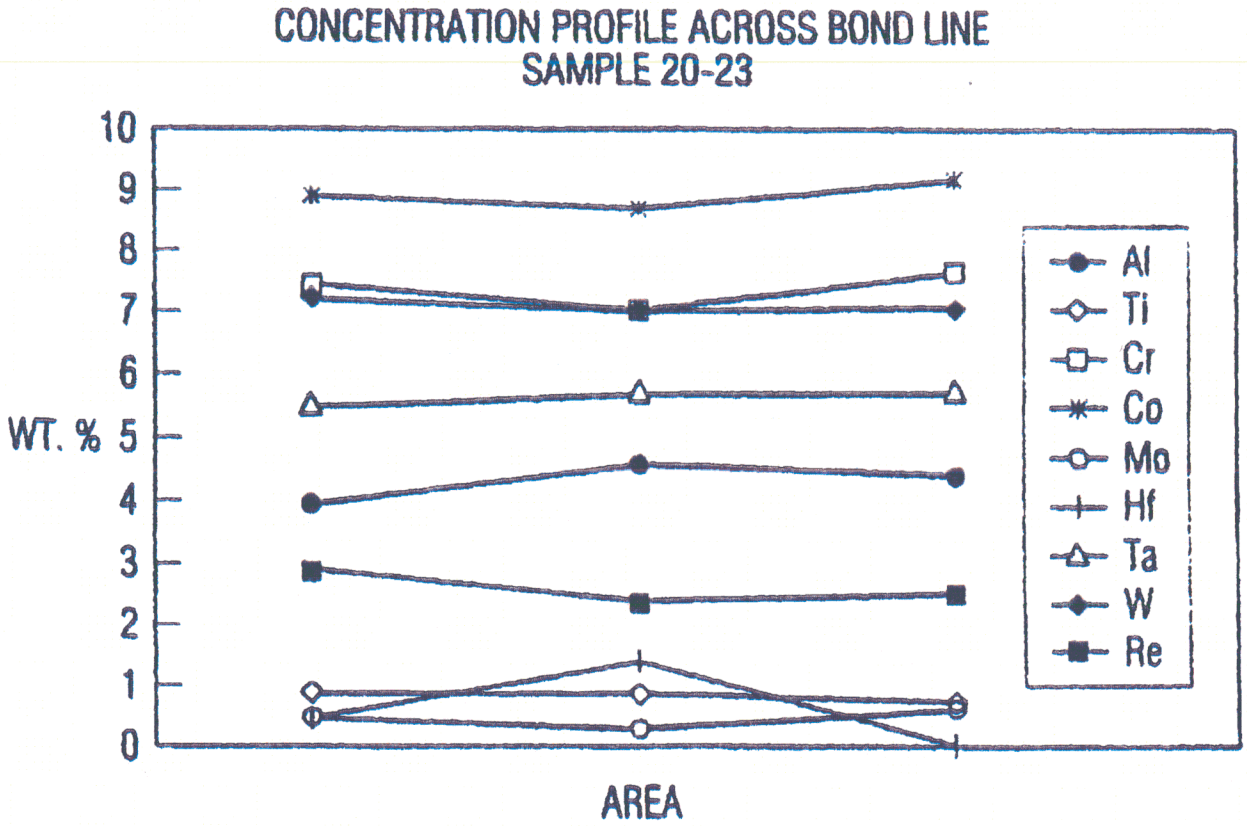


Grain Boundaries within a Diffused Joint

As cast CMSX4, Niflex 95
Matched orientation, 3hrs 1190C
No boundaries, but composition is not uniform

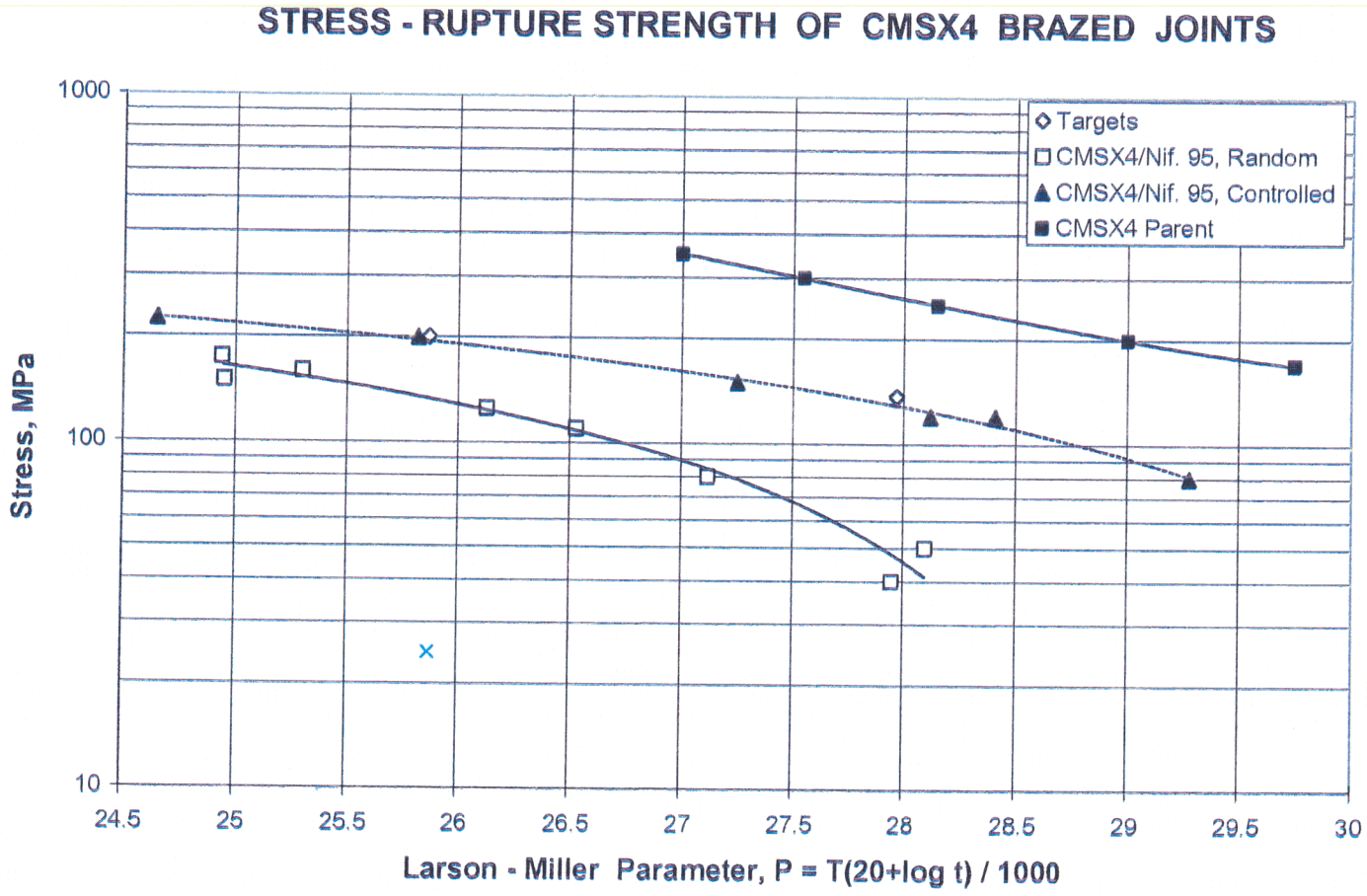
Normal CMSX4, Niflex 110
Matched orientation, 3hrs 1180C
Grains present

Brazing of Nickel Superalloys

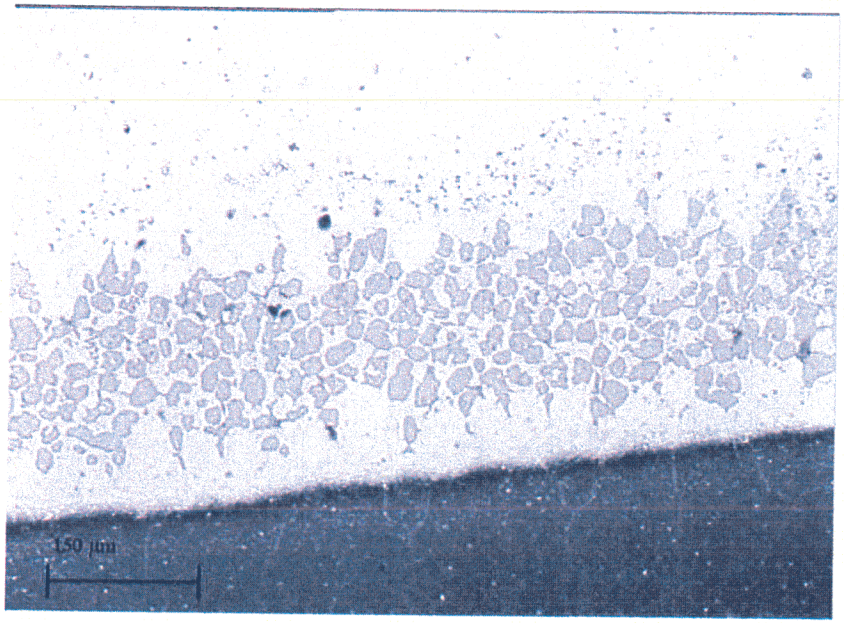


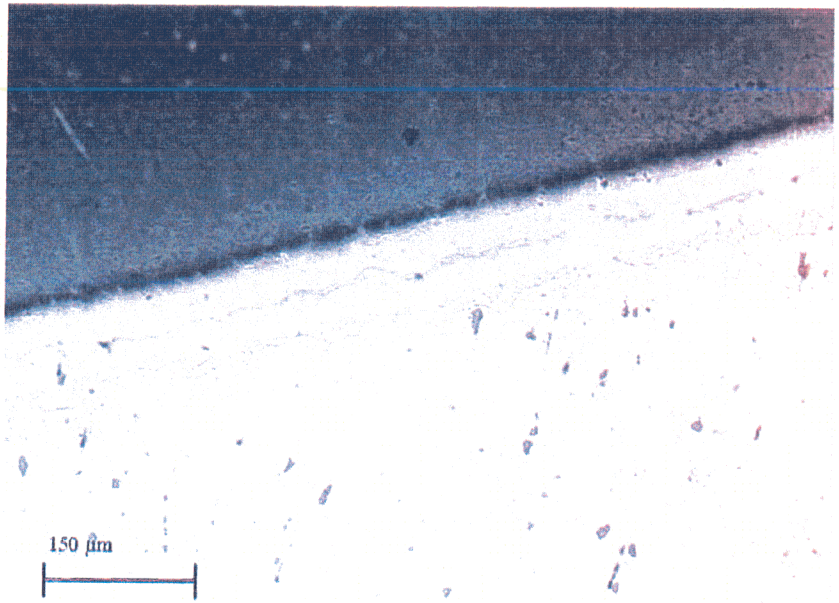
Plot from Siemens-Westinghouse Patent WO-9921681-A1

Brazing of Nickel Superalloys



Brazing of Nickel Superalloys

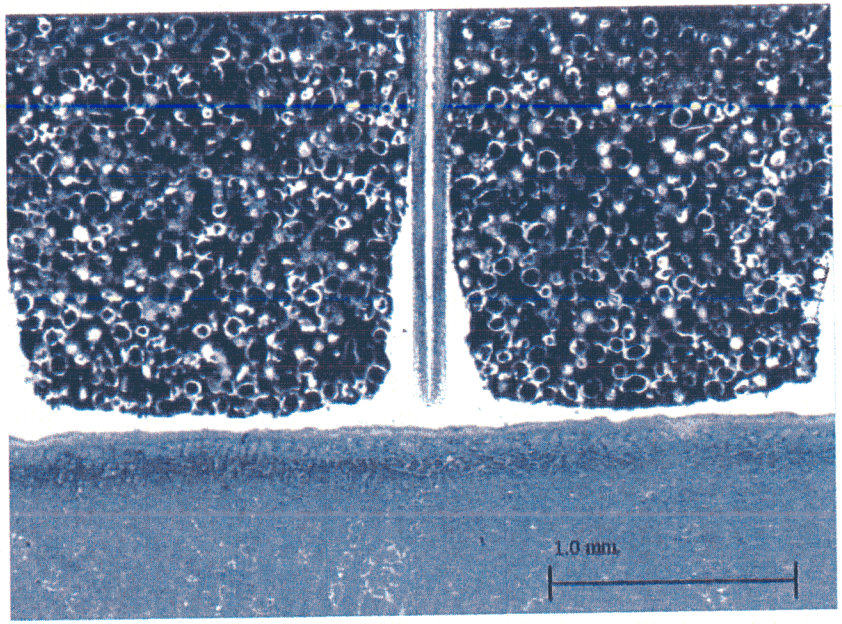


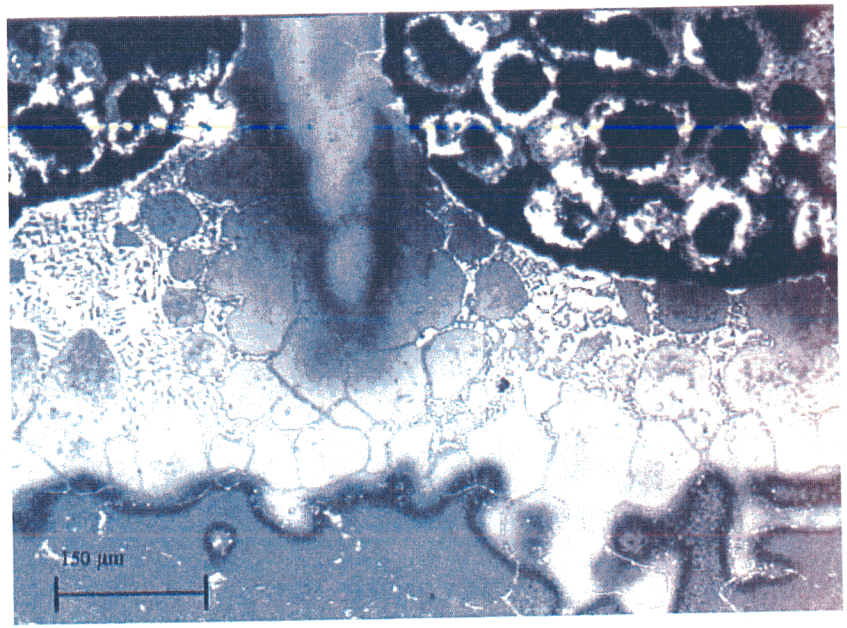


Effect of joint thickness on structure: 250 vs. 75 microns

OGV joint, HTN 4 (Ni – 3.5Si – 1.9 B), 15min. 1125C

Brazing of Nickel Superalloys



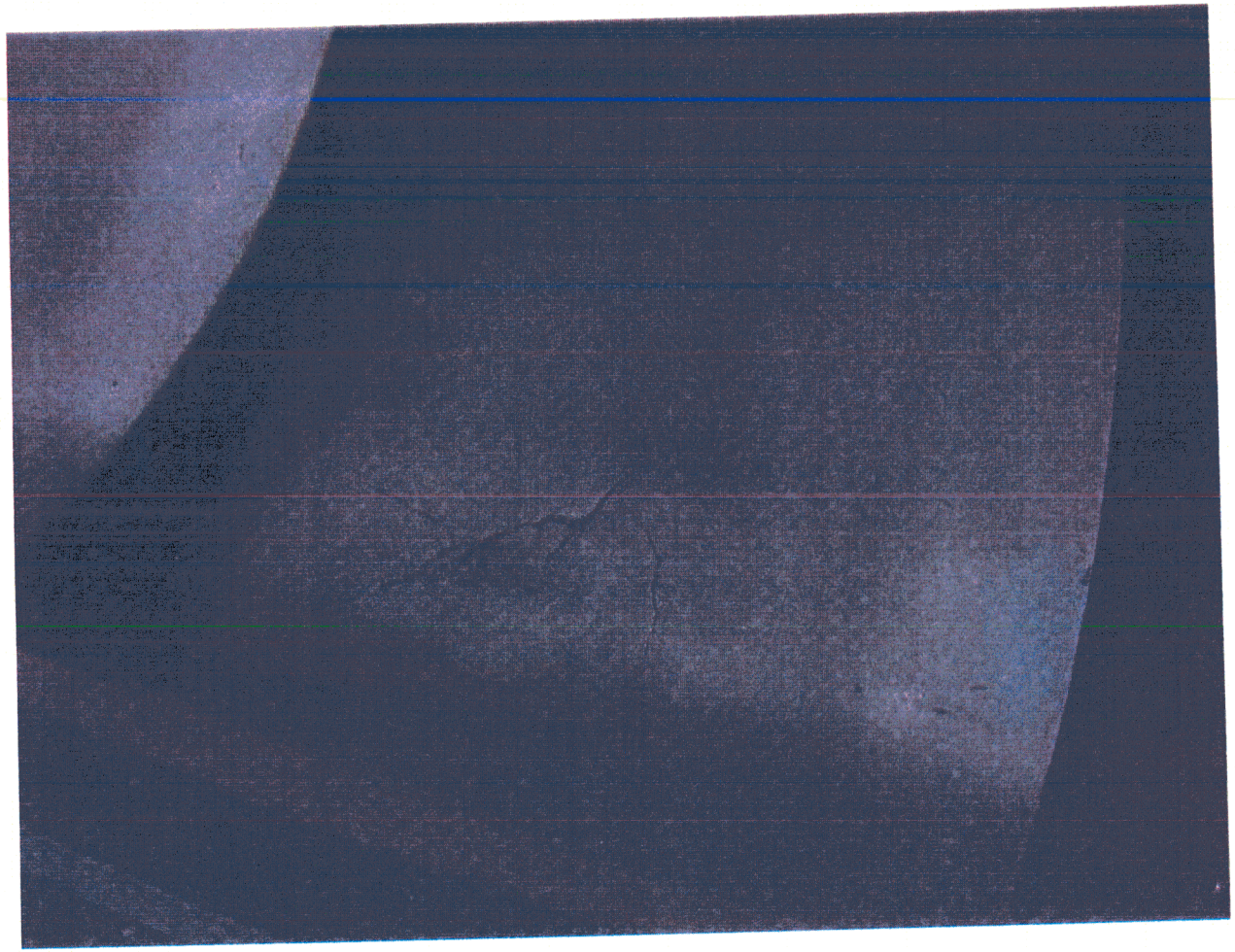


Honeycomb Braze Structures

Baseplate C1023 cast alloy, honeycomb Haynes 214 foil, braze HTN5,
8 minutes 1180C

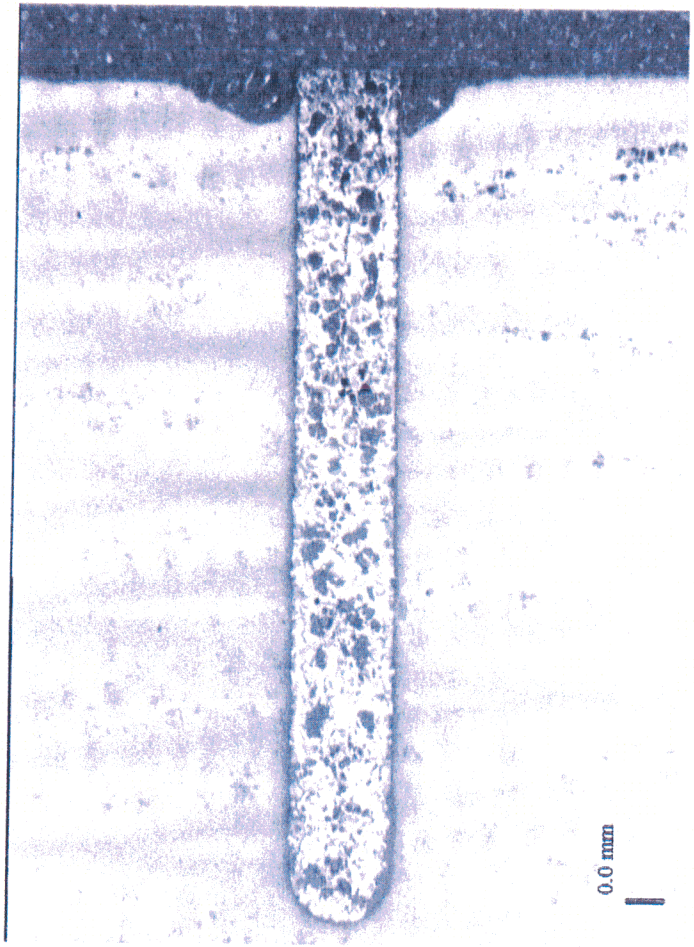
Demonstrates wicking, and equilibrium structure after engine running

Brazing of Nickel Superalloys



Engine - run HP vane in MAR-M002

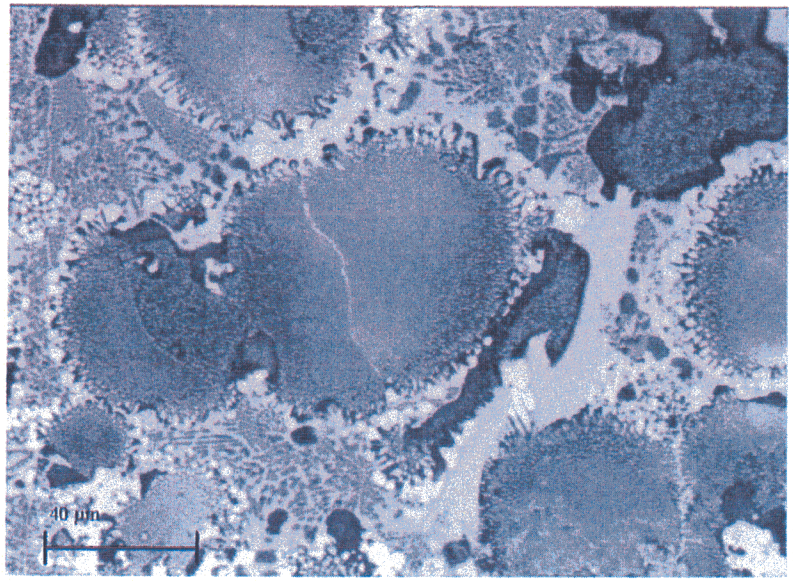
Brazing of Nickel Superalloys



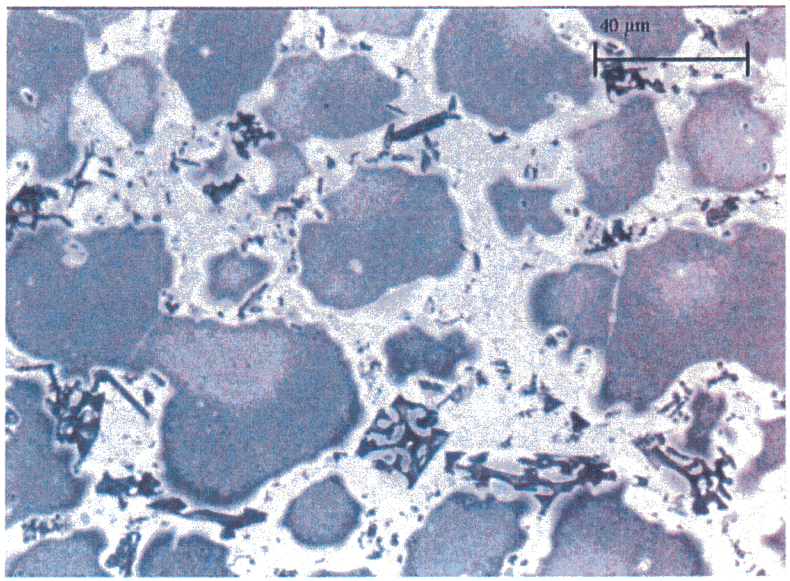
Slot-filling trial with
Experimental repair braze

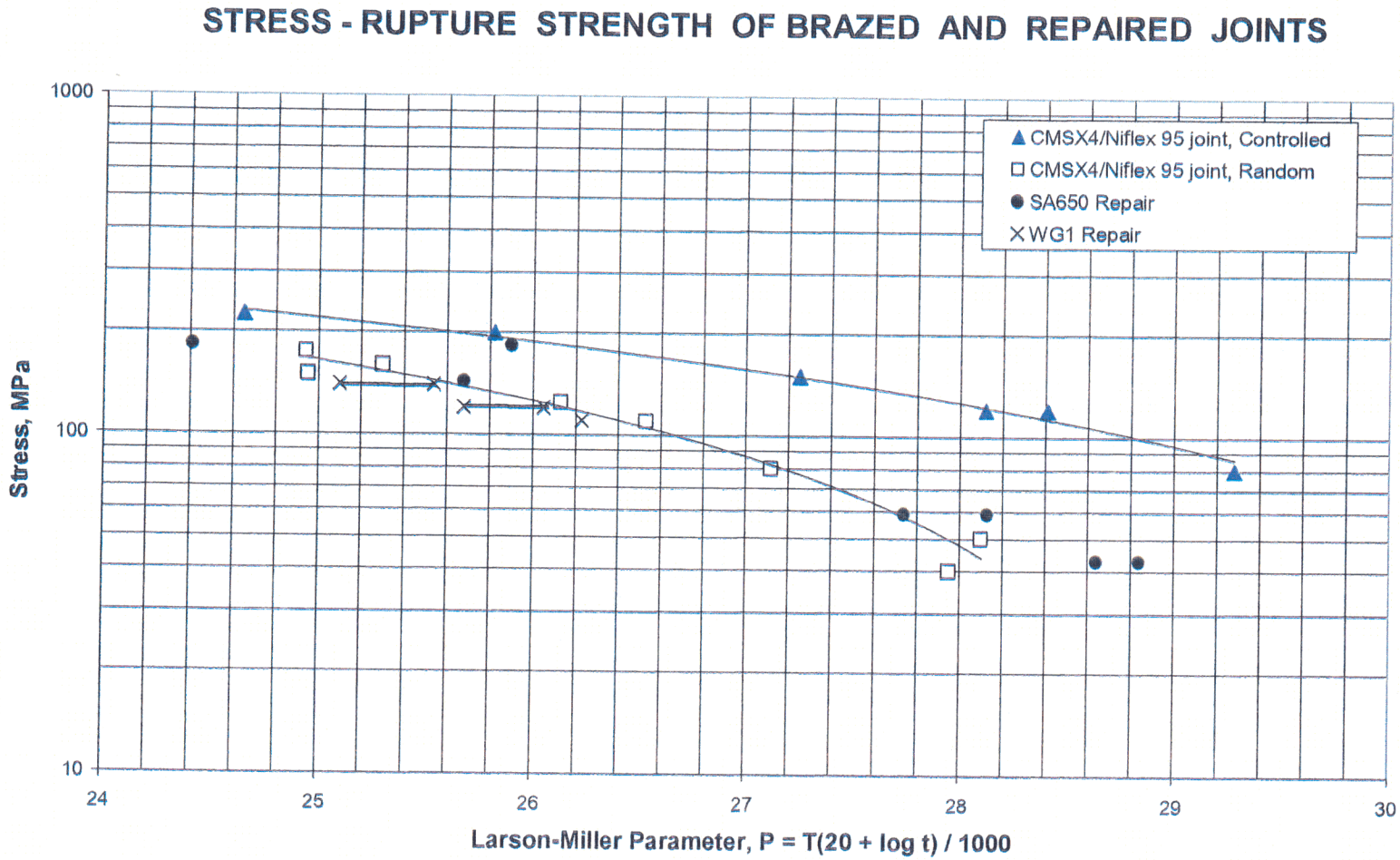
Brazing of Nickel Superalloys

Repair Braze Structures



Experimental Hf + B containing



Liburdi Proprietary

Brazing of Nickel Superalloys