



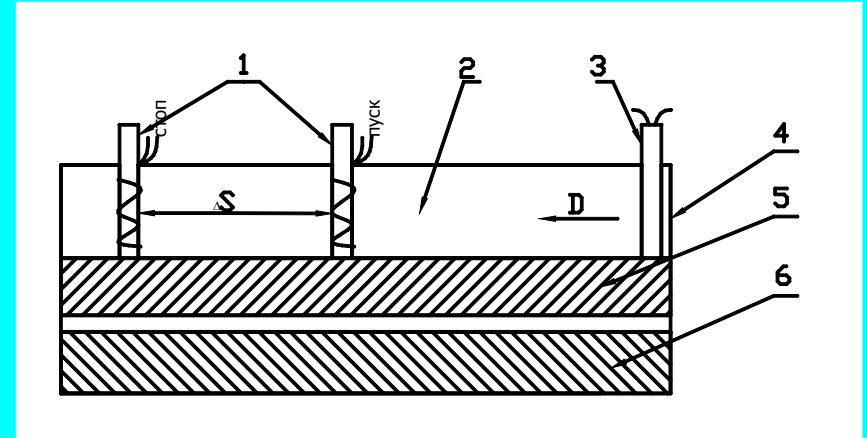
YUZHNOYE

design office

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**INDUSTRIAL EXPERIENCE ON EXPLOSIVE
WELDING OF STEEL - AL ALLOY TRANSITION
ELEMENTS FOR AEROSPACE APPLICATIONS**

Detonation velocity measurement

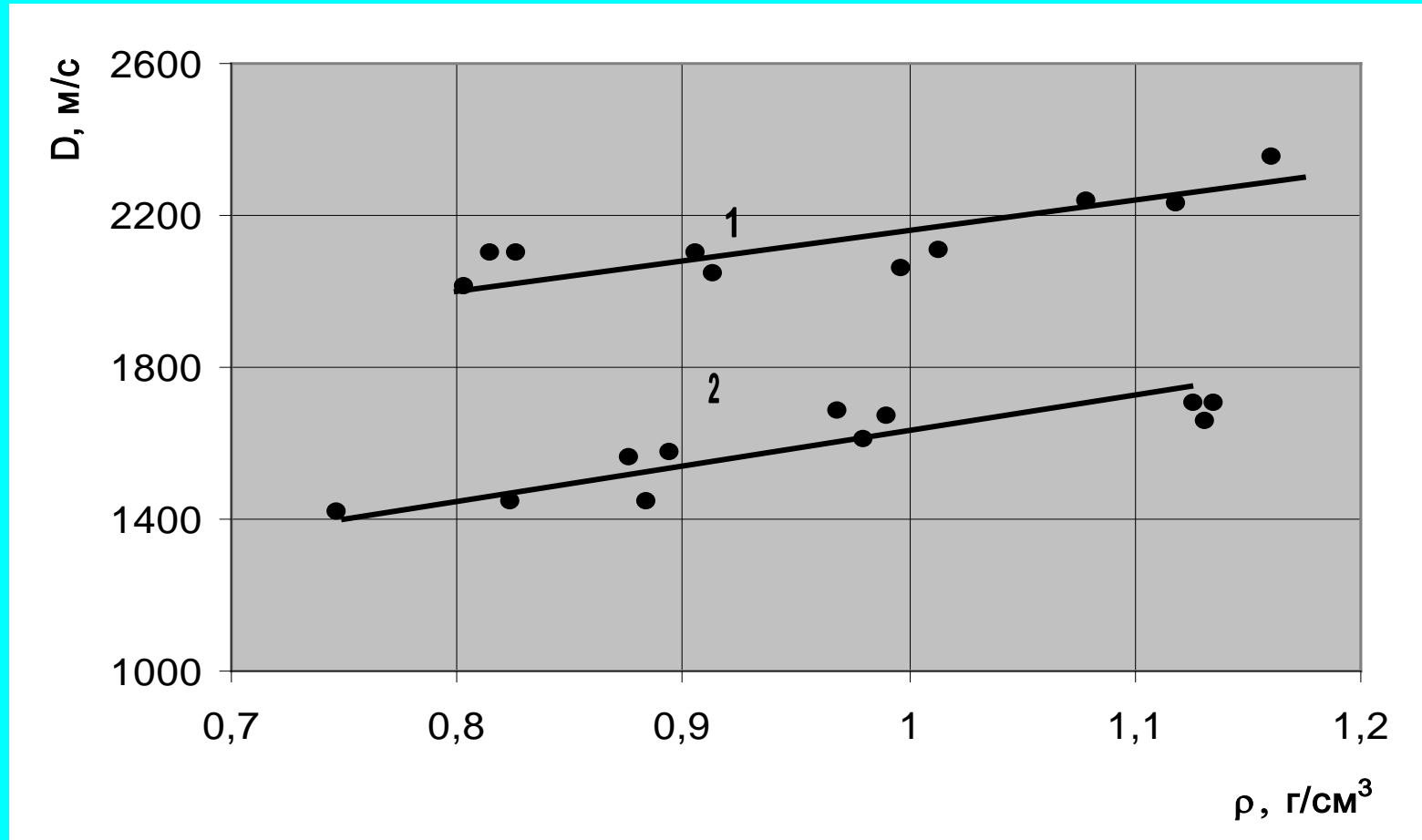


- 1 – sensors; 2 – explosive material;
- 3 – electrical detonator; 4 – cardboard collars;
- 5 – upper plate; 6 – lower plate

Detonation velocity dependence on size of ammonium nitrate particles

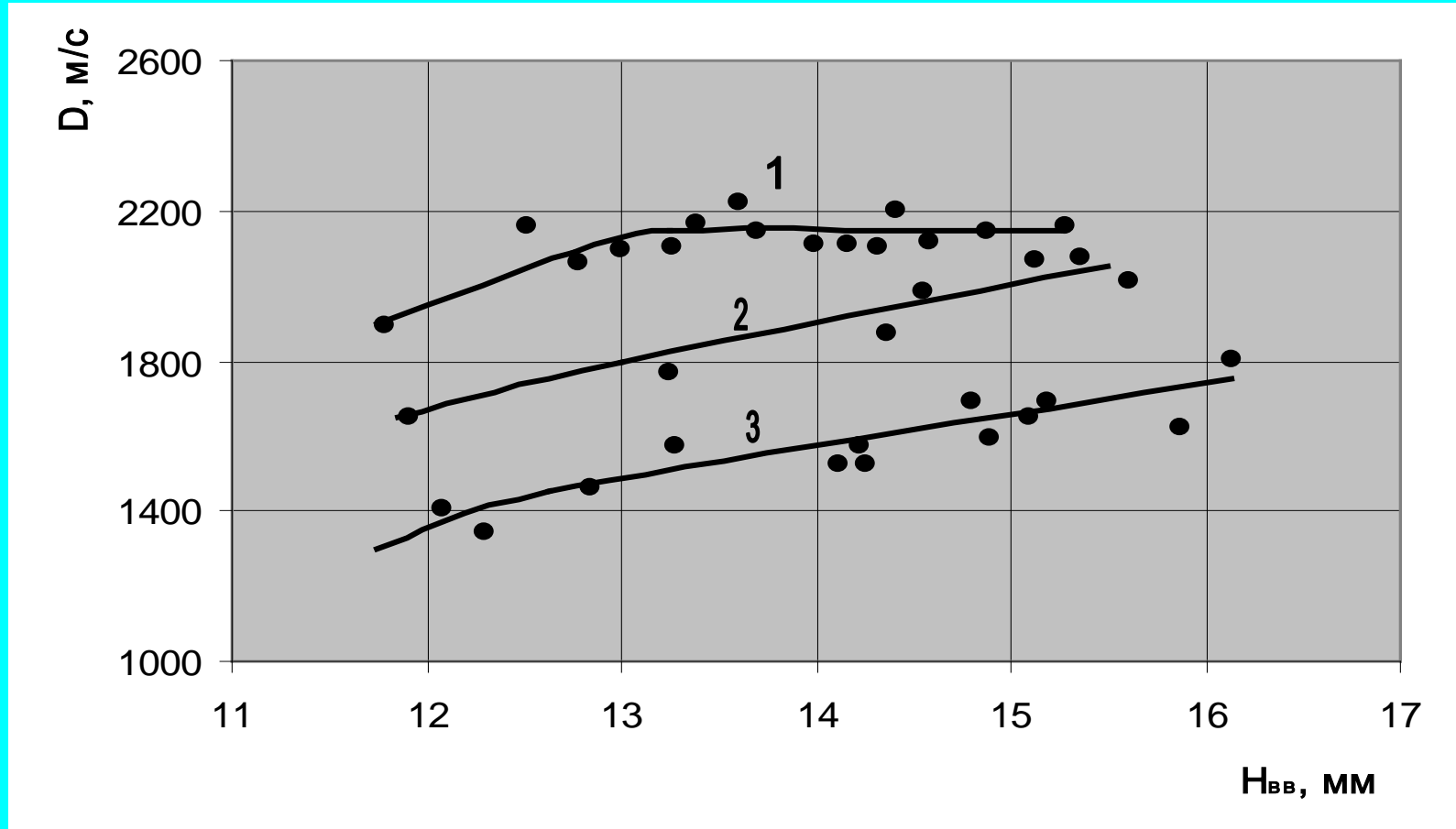
Size of particles, mm	Detonation velocity fluctuations, m/sec	
	AC14	AC27
2.5	1440±30	1890±190
2.5 – 0.84	1380±60	1860±140
0.84 – 0.36	1490±110	1780±30
0.36 – 0.16	1410±80	1810±40

Detonation velocity dependence of alloys on charge density at 20 mm thick charge



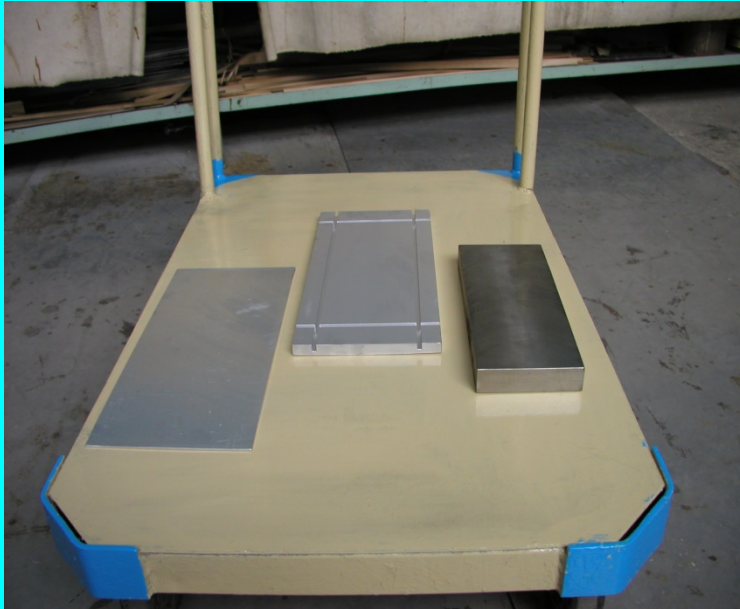
1 – alloy AC27; 2 – alloy AC14

Detonation velocity dependence of alloy on charge thickness



1 – alloy AC-33; 2 – alloy AC-27; 3 – alloy AC-14

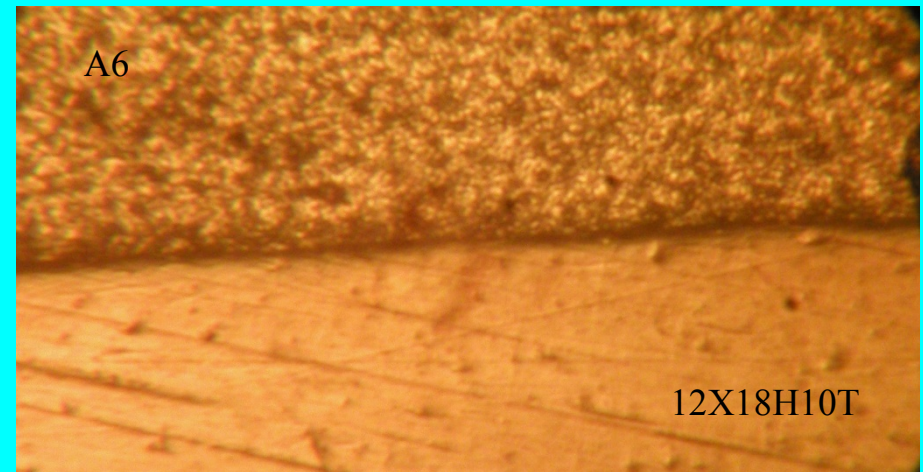
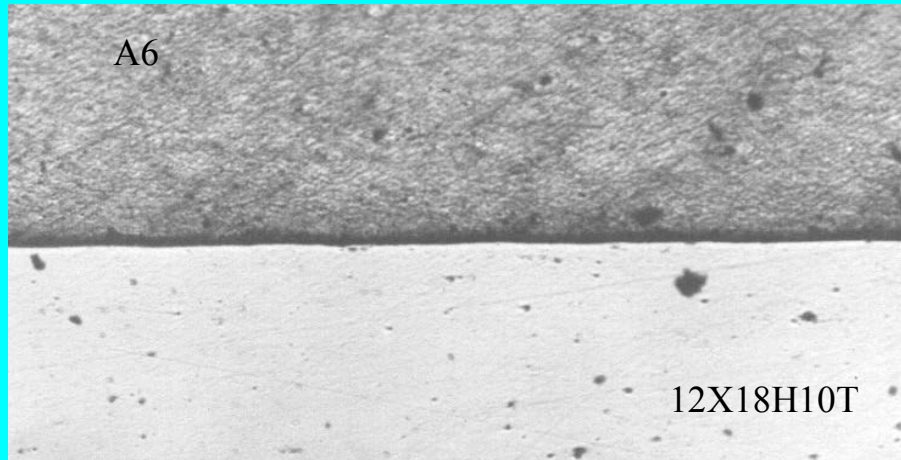
Explosion welding blanks and bimetals blanks



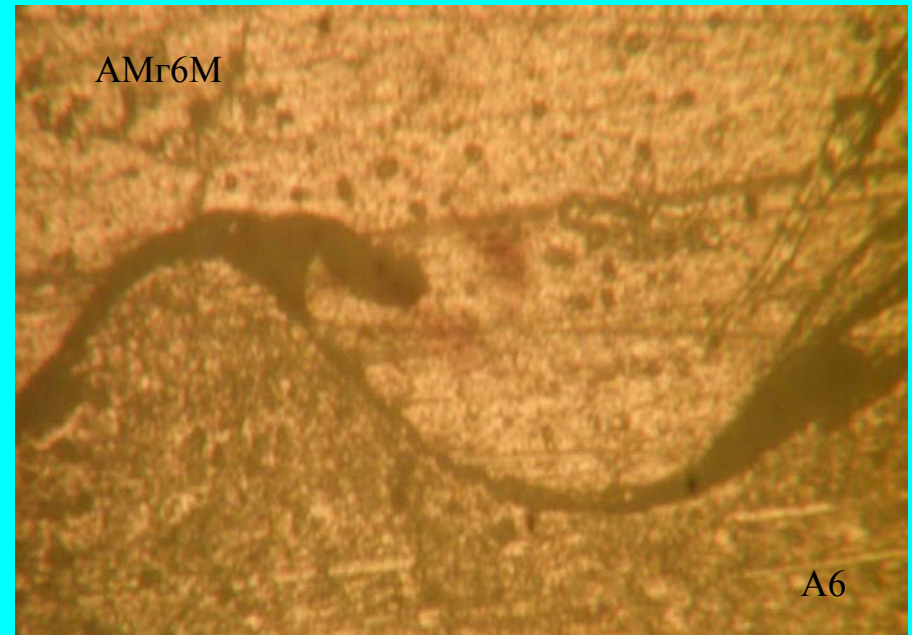
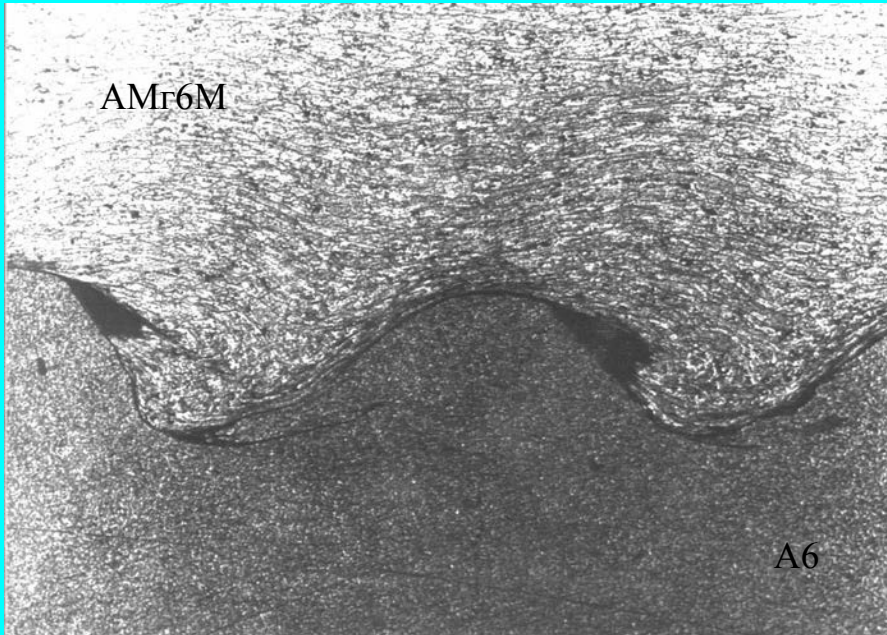
Ultrasonic inspection of bimetal blanks



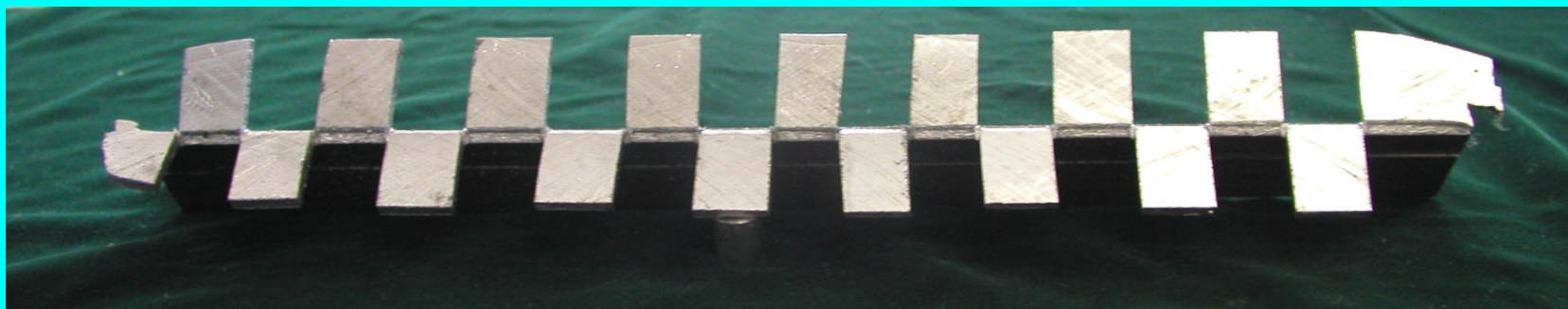
Boundary between stainless steel and aluminium



Boundary between Al-alloy and aluminium



Sample for bending test



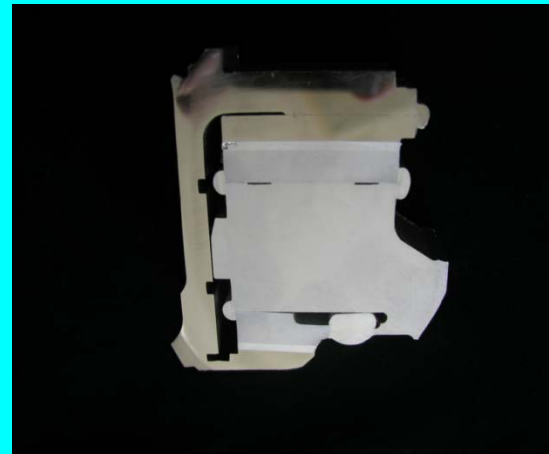
Tear test



Bimetal ring



- | | |
|---|----------------------|
| - Blank diameter, mm | 1800; |
| - Thickness of layers, mm: | |
| - 12X18H10T | 10; |
| - АД1 | 2; |
| - alloy АМг6М | 10; |
| - Joining strength of layers, kgf/mm ² | min 8 |
| - Helium inleakage, micron l/sec | min 10 ⁻⁵ |



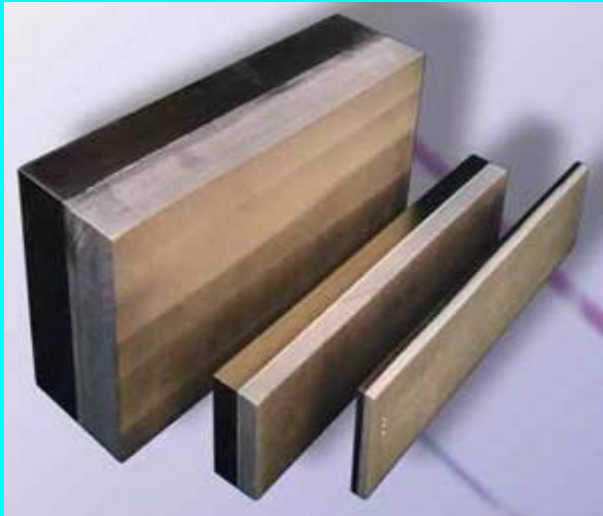
Trimetal main pipeline



- Pipe length after mechanical processing, mm 6800;
- Pipe weight after mechanical processing, kg 160;
- Pipe wall thickness, mm: $6,8 \pm 0,8$
- Joining strength of layers, kgf/mm² min 8
- Helium inleakage, micron l/sec min 10^{-5}



Steel-Al alloy composition



Use of multilayer metal compositions for manufacture of transition elements eliminates the problem of making constructions of dissimilar metals and alloys.

Basic advantages:

- High joining strength of metal layers;
- Leak-proof joining of metal layers;
- Corrosive medium durability

Explosion welding has been applied at Yuzhnoye SDO for manufacture of transition elements with diameters of 20 ... 1500 mm and surfaces of 450 x 500 mm

Thickness of layers, mm:
40-2-40;
15-2-20;
10-2-10

Joining strength of layers, kgf/mm² min 8

Helium inleakage, micron l/sec min 10⁻³

Steel-Al bimetal adapters are used in feeding lines of rocket engine supply system



Bimetal transition elements manufactured for Aerospatiale



In the context of international cooperation the department was among the first ones in Yuzhnoye SDO who has fulfilled the contract with French company Aerospatiale on manufacture of bimetal accessory joints for Ariane-5 launch vehicle (1994-1995)

Adapters of 1201 alloy and 12X18H10T stainless steel



Capability of explosion-welding manufacture of 1201-alloy and stainless-steel transition elements using intermediate underlayer of commercially pure aluminium for cryogenic systems of Liquid Propulsion Systems Centre of Indian Space Agency has been determined by means of:

- Metallographic examination and strength mechanical testing of samples (pull-off force – 9.6 – 10.9 kgf/mm²);
- Cyclic tests of bimetal transition elements at +300 ... -196°C;
- Leakage testing of transition elements after cyclic tests using air-helium mixture

Bimetal transition elements for Cyclone-4 LV



Bimetal transition elements have been tested for vibration resistance and static strength as parts of support ring. They have also passed functional strength tests with 8 kgf/cm² compressed air and leakage tests with pressure of 3.2 kgf/cm²

Thank you for attention!