

New Copper Based Composite for Engine Valve Seat Directly Deposited onto Aluminium Alloy by Laser Cladding Process

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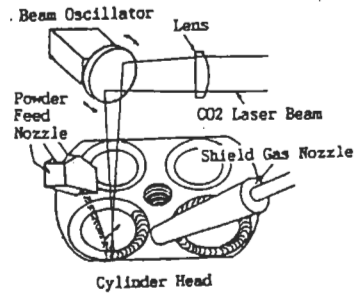
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A new type copper-based alloys for valve seat of automotive engines have been developed, which were directly deposited onto aluminium-alloyed cylinder head by a laser cladding technique.

These alloys have unique microstructures resulted from a rapid solidification of immiscible two liquid phases, in which coarse grains containing fine hard particles of borides and/or silicides (from liquid B) are homogeneously dispersed in the heat-resistant copper-based solid solution (from liquid A).

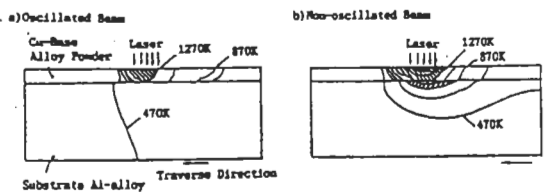
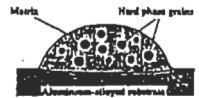
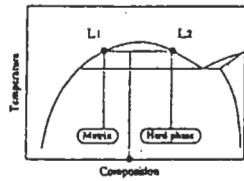
The controlled irradiation of a high-frequency oscillated CO₂ laser beam results in melting only the material powder for cladding on the aluminium-alloyed substrate and stirring the molten pool to form a homogeneous dispersion of liquid B in liquid A, and then rapidly solidified to freeze the dispersion by the heat conductivity the aluminium-alloyed substrate.

The deposited alloys provided considerable abrasive- as well as adhesive-wear resistances at a wide temperature range owing to the unique microstructures consisting of hard particles, heat-resistant matrices and/or lubricating phase.



Chemical analysis of the developed alloys. (mass%)

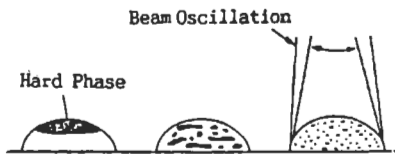
Alloy	Ni	Co	Mo	Fe	Si	Cr	B
A	19.6	—	—	7.8	2.7	—	1.3
B	15.8	7.6	6.7	5.9	2.9	1.6	—



Constituent phases of the developed alloys identified by X-ray diffraction and EPMA.

	Alloy A	Alloy B	Cu-based brazing alloy
Hard phase grain	(Fe, Ni) ₃ B (Fe, Ni) ₂ S (Ni, Fe) ₂ Si ₂	(Co, Ni, Fe) ₂ Mo ₂ Si Co-Ni-Fe-Si <S.S.>	—
Matrix	Cu-Ni <S.S.> (Ni, Fe) ₂ Si ₂	Co-Ni-Co-Fe <S.S.> Co-Ni-Fe-Si <S.S.> (Ni, Co, Fe) ₂ Si ₂	Cu-Ni <S.S.> Ni ₃ Si ₄ NiB

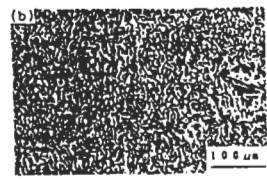
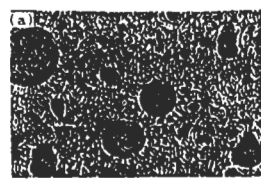
<S.S.> = Solid solution.



Slow → [Cooling Rate] → Rapid
 Weak → [Stirring] → Strong

Perfectly Decomposed → [Dispersion] → Homogeneous

Schematic Illustration of Dispersed Alloy Formation



Alloy A

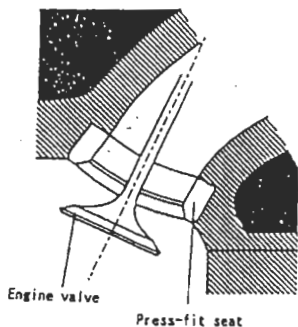
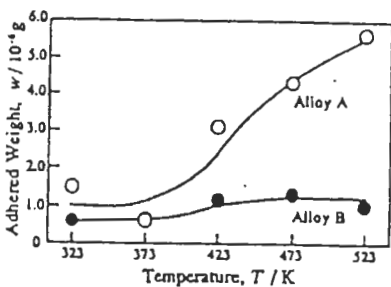
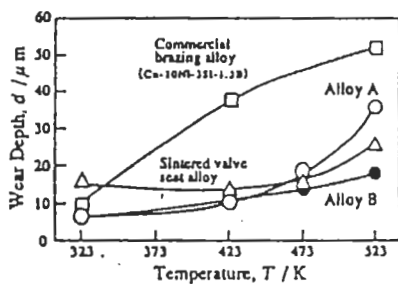
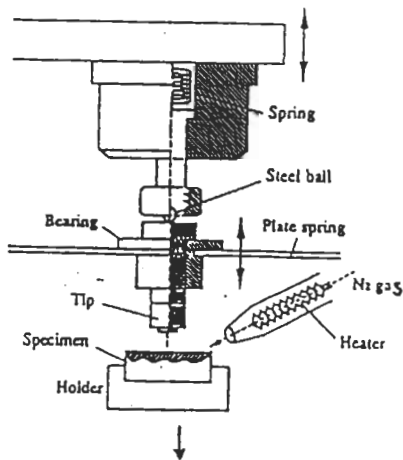
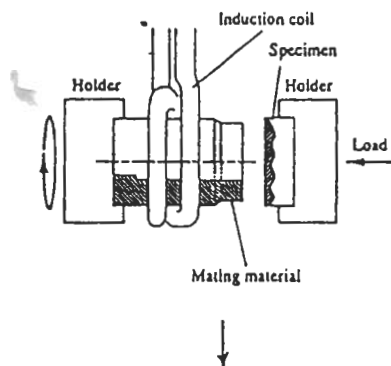
Alloy B

Condition of the thrust-collar type wear test.

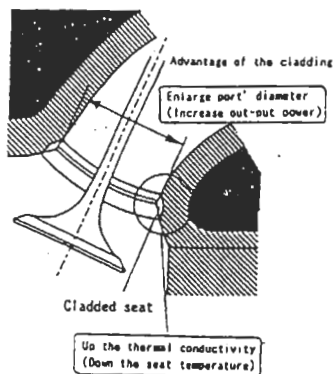
Load	2.0 MPa
Sliding speed	0.3 m/s
Testing time	1.2 ks
Surface temperature	323-523 K

Condition of the hammering type adhesive wear test.

Maximum load	9.8 MPa
Hammering frequency	16.7 Hz
Testing time	3.6 ks
Surface temperature	323-523 K



(a) Press-fit type seat



(b) Cladded seat