

TRIBOLOGICAL EVALUATION OF LASER ALLOYED AISi-CASTINGS BY MEANS OF CAVITATION

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ABSTRACT

Cavitation may appear at ship propellers, water turbines, fluid pumps, pipes, as well as on cylinder liners of diesel engines. Microjets (dia.: 1 μm) hit the surface with a speed of about 200 to 1000 m/s and lead to local impact stresses of several 100 MPa to GPa for periods smaller than 1 μs . This brings about a loss of material, deterioration of performance, and destruction of the entire machine part (1). The major acting wear mechanism is surface fatigue. Thus, the measures to counter wear by cavitation are change of design, working parameters, and change of materials in order to gain high strength and toughness. Beside others this can be brought about by surface techniques gaining fine microstructures with sufficient hardness and toughness in order to achieve tribological stability. With laser cladding and alloying the major advantage lies within the high energy density, which can be varied within a wide range in order to govern the heat input. The high solidification rate brings about fine homogenous microstructures depending on the chemical composition of the involved materials and cladding parameters (2, 3). The aim of this work is the characterisation of wear behaviour of laser alloyed surfaces of AISi-castings under cavitation.

Testing Materials: Laser alloyed AISi9Cu castings as well as the base materials of AISi9Cu and AISi17Cu4Mg castings have a microstructures consisting of a metal-matrix (AlSi solid solution) with eutectic (Si) and primary (NiAl intermetallics, Si) hard phases. (Table 1).

Base	Laser Alloyed with	Eutectic Hard Phases	Primary Hard Phases
AlSi9Cu	Ni	Si, Al ₂ Cu	NiAl
	Si	Si, Al ₂ Cu	Si
AlSi9Cu	-	Si, Al ₂ Cu	-
AlSi17Cu4Mg	-	Si, Al ₂ Cu	Si

Base Alloys: The metal matrices of both base alloys consist of an AlSiCu solid solution with a hardness values between 90 and 180 HV_{0,05} depending on heat treatment. The hard phases are eutectic Si as

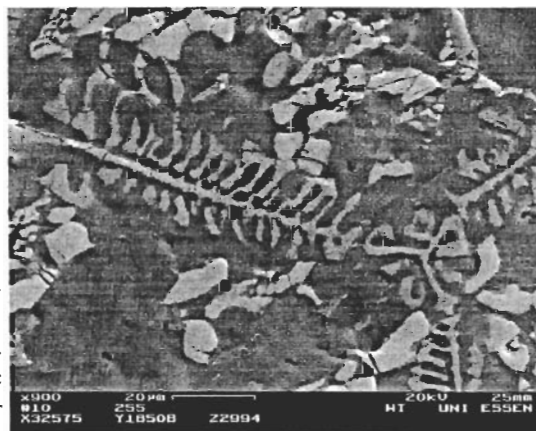


Figure 1: Microstructure of cast AlSi17Cu4Mg (Cavitated for 2 min)

Table 1: Groups of Materials Tested

well as eutectic Al₂Cu. The hypereutectic 17% Si containing alloy has primary Si particles with a hardness of 1000 HV_{0,05} (Figure 1).

Laser Alloyed Surfaces: The laser alloyed surfaces show a much finer dendritic microstructure with primary hard phases of Si or NiAl depending on the alloying element.

Testing and Results: Tests were carried out in accordance with ASTM G-32-77. The incubation period is limited by the first measurable weight loss. Cavitation rates were determined by weight loss

related to the testing time (Figure 2). The set up was calibrated using annealed pure Ni. The reproducibility is better than 10 %. The worn surfaces were investigated using an SEM in order to determine the wear appearances.

Discussion: During incubation period worn surfaces appear like being chemically deep etched (Figure 1). The metal matrices are worn predominantly. The differences between the materials are related to the stability of the metal matrix, which is governed heat treatment, and the volume fraction of primary hard phases. The highest erosion rates show the conventional castings, while laser alloyed surfaces reveal a distinctly lower erosion weight loss (Figure 2). The loss of material concentrates

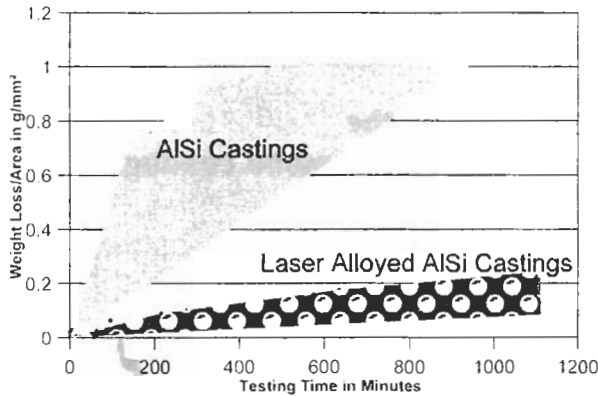


Figure 2: Measured Cavitation Rates

on the metal matrix and the eutectic. Thus, the primary hard phases protrude from the surface until they loose their support and are worn away by microcracking. As a result the microstructures are totally destroyed (Figure 3).

REFERENCES

- (1) H.Rieger; Kavitation und Tropfenschlag. Werkstofftechn Verlagsgesellsch. mbH, Karlsruhe (1977) S.7-13
- (2) A.Fischer, G.Lensch; Technical Application of Laser Surface Treatment. Hardening, Alloying, Cladding. (Proc.Conf.) ECLAT '96, 16.-18.9.1996, Stuttgart, AWT, An den Quellen 1, 65183 Wiesbaden, Germany (1996) Pp.399-405
- (3) M.Bohling, A.Fischer, A.Ziege; Tribological Evaluation of Laser Treated Surfaces my Means of Cavitation. (Abstract) (Proc.Conf.) World Tribology Congress, 8.-12.9.1997, London, UK, ImechE, London, UK (1997) Pp.71

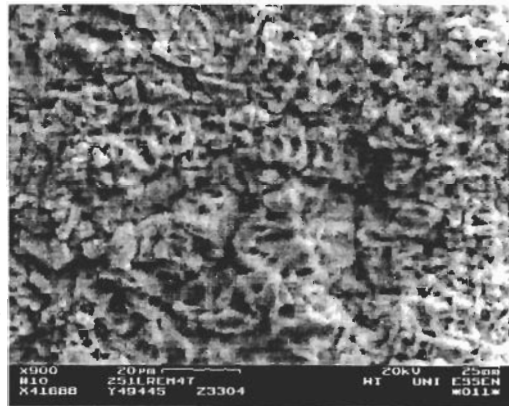


Figure 3: Cavitated (45 minutes) Surface of AISi17Cu4Mg Casting

keywords: AISi castings - laser alloying - cavitation - improved cavitation resistance