

The Running-in Behavior of AlSi as a function of Si morphology and final machining

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1. Introduction

The running-in behavior of a lubricated tribological system crucially depends on the development of the third body, which can be defined as the layer needed to accommodate the velocity difference between two first bodies in contact [1]. The properties of the third body are based on near-surface chemistry and microstructure. They are influenced by load, speed and chemical boundary conditions of the system, but also by the pristine microstructure of the two first bodies in contact. Whereas the external boundary conditions (load, speed) very often are fix, internal boundary conditions, as for instance the first body microstructure, can be changed by the variation of processes, e.g., during casting or final machining. Creating beneficial conditions for a good running-in behavior by the adaption these process parameters is an important tool for the production of tribologically stressed devices.

Due to its lightweight properties, AlSi-alloys are increasingly used for components operating under severe tribological conditions. The present study focusses on the influence of subsurface microstructure on the running-in behavior of the AlSi9Cu3 (disk) and 100Cr6 (pin) tribocouple. To assess these influences, equally machined disks with different silicon morphologies as well as differently machined disks with equal silicon morphologies were tested under identical loads and speeds.

With the addition of strontium, the morphology of the eutectic silicon phase in aluminum-silicon alloys changes from a plate-like to a fibrous morphology [2]. The eutectic modification improves the mechanical properties of the cast alloy.

Subsurface microstructure was also changed by the application of cutting tools. The variation in shape resulted in different ploughing forces and as a consequence in differences in grain sizes, residual stresses and hardness values.

2. Experimental

All tests were performed on a pin-on-disk tribometer with a sliding velocity of 0.8 m/s and a contact pressure of 25 MPa during the running-in period. The running-in behavior was characterized by friction, total wear, wear rate and also system stability (i.e. the change of friction and wear rate in a certain operating point in dependence of the history of the system).

Stribeck curves were measured after completed running-in in order to determine friction in a broad range of velocity/load-combinations and to assess the

stability of the system.

Subsurface microstructure was changed by the addition of 200 ppm strontium to achieve a fine, needle-like morphology instead of a coarse plate-like Si phase. Additionally, machining with different cutting tools yielded fine grained subsurface layers with thicknesses of 0.5, 1 and 3 μm , respectively. Roughness values of all samples were comparable.

The third body of the specimens was analyzed chemically with X-ray photo spectroscopy and microstructurally with FIB/SEM. Topography was measured by white light interferometry. The wear rate was measured using radionuclide-technique (RNT) [3] with the advantage of high resolution and *in-situ* monitoring of wear to determine wear rates with high accuracy.

3. Results

The Si morphology as well as the final machining influences the running-in behavior, i.e., friction and wear rate at the end of the running-in when the system has reached constant friction value and wear rate. Experiments showed that the refinement of the Si phase with strontium increases wear of the AlSi9 disk compared to the alloy without strontium.

It was also found that besides friction and wear rate, the consideration of system stability is an important criterion to analyze the running-in behavior.

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5. References

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