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Experimental studies on surface treatment of Titanium by new blasting techniques

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Introduction

Surface conditions of Titanium castings are influenced by interface reactions between Titanium and the investment material. There are the sinterfusing and uptake of elements from the investment material and formation of an oxygen rich surface layer (µ-case). The usual surface treatment is sandblasting with corundum 250µm. It´s characterised by strong surface roughening, plastic deformation, microstructural defects and impaction of blasting grains. That's why there is a new technique of surface treatment developed so called micro-finishing. An abrasive and spherical medium are used in this technique.

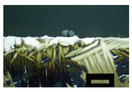
Fig.1: casted Titanium, cleaned in an ultrasonic bath


Fig.2: sandblasted Titanium (corundum 250µm)

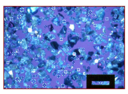
Fig.3: abrasive Medium 1 (M1)

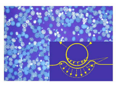
fig.4: spherical Medium 2 (M2)

Objective

The aim of the following investigation was the experimental evaluation of this micro-blasting method, using the abrasive and spherical medium separate and in combination.

Material and Methods

Casted samples of Titanium (grade 1; Biotan®) were used in following initial surface conditions:
- casted and cleaned in an ultrasonic bath
- wett ground on SiC-paper, grit size 220,600,1200

The samples were finished by using the abrasive and spherical medium, separate and in combination. The surface conditions were characterised by using:
- light- and scanning electron microscopy (SEM)
- light microscopically investigation on metallographic transverse sections
- analysis of the profile graphs (R_{ZD},S_m)

Results

Micro-finishing of surfaces in cast condition

1. Surface condition after using the fine-grain abrasive medium (M1): Sinter-fused particles are removed and there's a surface roughening, but lower compared with usual sandblasting, the oxygen rich surface layer is reduced and there are no plastic deformations or microstructural defects.
2. Surface condition after using the spherical blasting medium (M2): The M2 effects a surface levelling by plastic deformation (ball imprints); the oxygen rich surface layer is low reduced.
3. Surface condition after using medium 1 and 2 in combination: There is a cleaning and smoothening effect: the surface roughening by the abrasive blasting is levelled by micro-peening, the µ-case is clearly reduced, the surface is smoothed and there are no microstructural defects.

Fig.5: sandblasted Titanium (corundum 250µm)

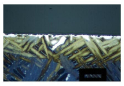

Fig.6: casted Titanium, finished by using M1

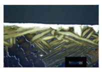

Fig.7: casted Titanium, finished by using M2

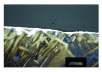

Fig.8 casted Titanium, finished by using M1+M2

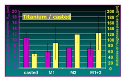

Fig.9 analysis of the profile graphs

Micro-finishing of ground surfaces

1. Ground surface with SiC220 before micro-finishing shows a removed µ-case, small deformation range and roughened surface. After using M2 there are wide deformation ranges (slip bands up to 30µm) and impactions of blasting grains.
2. Ground surface with SiC1200 before micro-finishing shows slight surface roughening and minimum deformation range. After using M2 there are wide deformation ranges (slip band up to 25µm) and impactions of blasting balls.
3. The evaluation of the profile graphs demonstrates a levelling affect of grinding and fine grinding before micro-finishing (roughness depths between 1,1 and 0,9 µm). The micro-finishing effects an increase of roughness depths up to 2,4 µm.

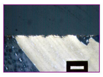

fig.10: ground surface (SiC 220)

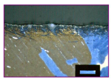

Fig.11: ground surface, finished with M1+ M2

Fig.12: fine ground surface (SiC 1200)

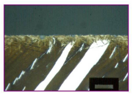

Fig.13: fine ground surface, finished with M2

Discussion and Conclusions

1. The abrasive micro-blasting of Titanium castings removes surface near layers. In contrast to the usual corundum blasting the method shows an levelling effect. Microstructural defects are diminished.
2. Micro-peening in combination with foregoing abrasive micro-blasting effects a further levelling and compaction of the surface.
3. Abrasive micro-blasting and micro-peening of fine-ground surfaces is of no use.
4. The micro-finishing technique enables a rationalization of surface finishing and improvement of surface quality of Titanium castings.

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Abbreviations

RZD - average depth of roughness
Sm - medium distance of roughness peaks

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