FATIGUE BEHAVIOR OF SINTERED METAL PARTS FROM POWDERS.

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Abstract: *Last test research in the field of powder metallurgy show concern over attempts fatigue. Have been made to predict the the endurance limit to fatigue for predicting the effect of residual porosiy an the tensil strenght. It was found that the surface finish of the samples has a great influence on the fatigue strength. The sample containing pores - those caused by transient liquid phase by the Mo particle - the adverse effect of such flaws on the fatigue strength, which was also found by testing the fatigue .*

Key words: powder metallurgy, fatigue strength, porosity, sintering.

1. INTRODUCTION

In recent years many attempts have been made to assess the strength limit parallel models for predicting the effect of residual porosity on tensile strength [1,2,3]. There exist two types of porosity influence the mechanical properties of PM materials . The “primary” porosity is already existent in the green compact , i. e . more or less eventually distributed , and can be seen as an integral value . The “secondary” porosity is formed during liquid phase sintering and is equal to singular defects . This can occur in case of sintered alloys produced out of elemental powder mixtures such as Fe-Cu , Fe-Mo-C [4]. The advantages of elemental powder mixtures are a better compactibility , flexibility and availibility . The homogenization of the alloying metal is attained in the case of Fe-(1,5-2)% Mo-0,6% C during transient liquid phase sintering above a critical temperatures of 1243®C. It is known that most conventional steels of fatigue cracks are initiated at the surface may occur [bad and internal defects in the case of solidification.

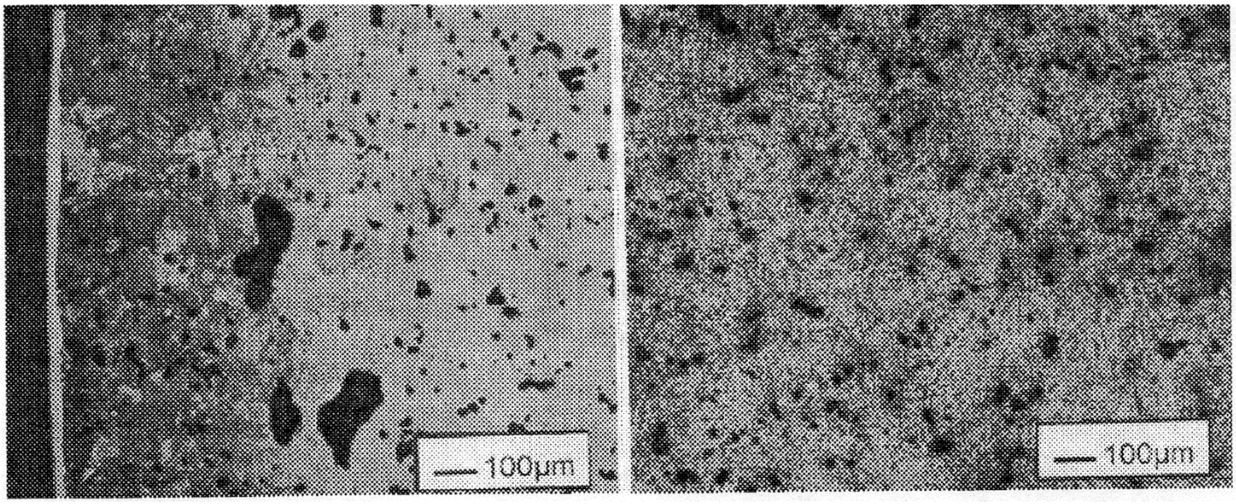
2. EXPERIMENTAL

Rectangular samples (90 mm X 12mm X 12 mm) of the chemical composition of Fe-(1,5-2)% Mo-0,6% C were produced by different alloying techniques Probele au fost dublu presate pentru a obține o densitate de aproximativ 7,4 g / și sinterizate la 1250 C timp de 120 minute în vid. O parte din exemplarele au fost suplimentar tratate cu NITAL timp de 4 minute și repolishate. Testarea a avut loc la temperatura camerei și a fost prelungit până la cel puțin cicluri de încărcare.Fatigue specimen groups of the chemical composition of Fe-(1,5-2)% Mo-0,6% C manufactured from different powders, table 1.

Table 1. Fatigue specimen

Powder composition	Density (g/cm^3)	State
100% Mo <25 μm	7.38	Heat treated
1% Mo 45-63 μm	7.38	Heat treated
10% Mo45-63 μm	7.37	Heat treated
100% Mo 45-63 μm	7.28	Heat treated
Fe-1.5% Mo (preall)	7.25	Heat treated
1% Mo 45-63 μm	7.38	Plasma nitrided
10% Mo 45-63 μm	7.37	Plasma nitrided

Metallographic sections of of Fe-(1,5-2)% Mo-0,6% C sintered at 1250 °C/120 min a) elemental Mo10% 45-63 μm plasma nitride , b) prealloyed , heat treated , figura 1.



a) b)

Fig 1. *Metallographic sections of of Fe-(1,5-2)% Mo-0,6% C sintered at 1250 °C/120 min a) elemental Mo10% 45-63 μm plasma nitride , b) prealloyed , heat treated .*

3.RESULTS AND DISCUSSION

Different sample groups which were tested are listed in Table1. The system Fe-(1,5-2)% Mo-0,6% C was sintered in the case of elemental powder mixtures with a transient liquid phase which is formed above 1250°C . Aboce this temperature the liquid flows into the primary pores and pressing contacts , leaving secondary pores of double the powder size in the location of the original Mo particles. The prealloyed powder Astaloy Mo exhibits a different microstructure with regard to the pores . Numerous small pores with a maximum radius of 10 μm are found . A comparison of metallographic sections can be see in Fig.1 (elemental powder mixture plasma nitride ; prealoyed Astaloy-Mo) The ground surface contains many parallel scratches which are not sufficiently large to initiate a fatigue crack . The polished surface is smooth without visible porosity , which can be reopened after etching and repolishing.materials manufactured with Mo<25 μm (see Fig.4). The data obtained with specimens which were additionally etched and repolished , in contrast , with visible porosity , have lower values due to now existing crack initiation sites. Acomposition made with Mo<2514μm contains secondary pores of about 50 μm size. The material produced with 10 % Mo 45-63 μm obtained an endurance limit of 370 MPa and a higher scatter resulting out of an interaction of stress dields around adjacent secondary pores .The influence of the alloying technique on the S/N data is demonstrated in Fig.2. The material made from prealloyed Fe-4% Mo can be refarded as almost “singular defect- free” and as reference material . No secondary pores are visibile and the sizes of primary pores is <30μm . The crack initiation in this case occurs from a pore agglomerate.

Another possibility to improve the fatigue properties is to decrease the surface porosity , for example by plasma nitriding . Plasma nitriding was performed under a low temperature of 550 °C , so that no dimensional change occurred . Metallographic evaluation showed a 20 μm thick nitride boundary area followed by 250 μm diffusion area.

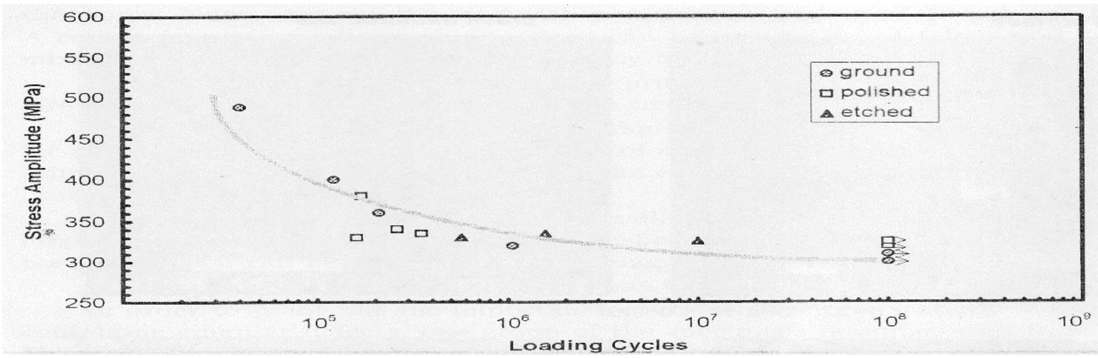


Fig.2. *S/N cureves of a heat treated prealloyed Fe-1.5 %Mo-0.7%C(Astaloy-Mo); influence of the surface condition .*

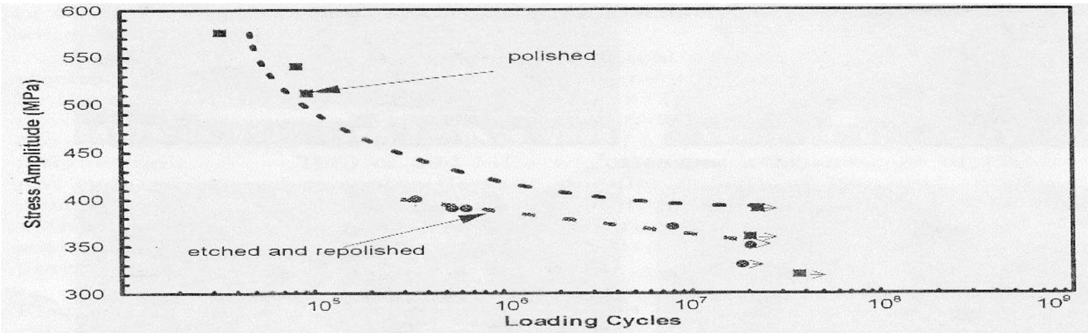


Fig. 3. *S/N curves of heat treated PM-steels Fe-1.5%Mo-0.7%C (100%Mo 45-63 μm) ; influence of the surface condition .*

Microhardness decreased lineary from 450 HV 0.05 on the specimen surface . down to 300 HV 0.05 at the end of the diffusion zone (250-280 μm from the surface) . The results indicate that plasma nitriding improves the S/N data even more that heat treatment(Fig. 4)

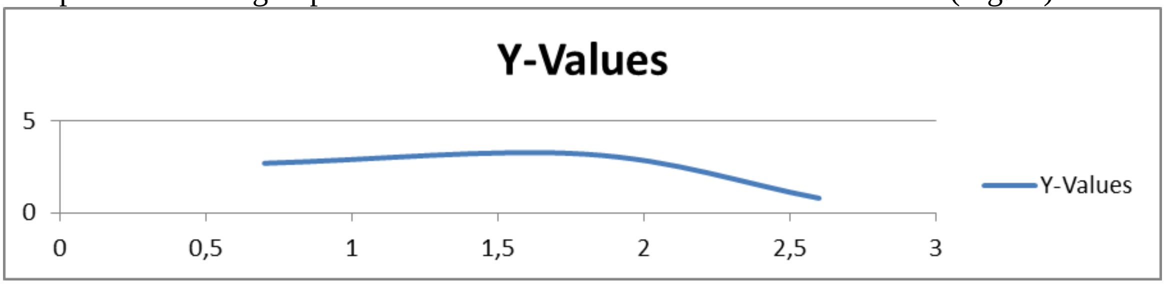


Fig.4. *S/N curves of heat treated PM-steels Fe-1.5% Mo -0.7%C ; influence of the secondary porosity , etched and repolished .*

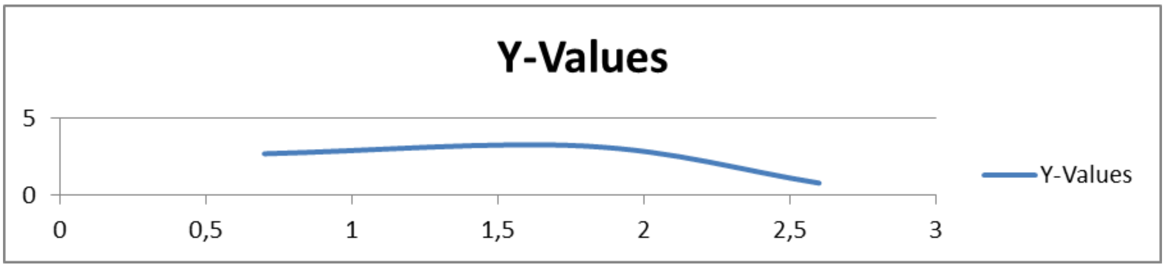


Fig. 5. *S/N curves of heat treated PM-steels Fe-1.5 % Mo-0.7% indicating the influence of alloying techniques.*

The reasons could be the dense coating and additional compressive residual stresses .

4. CONCLUSIONS

The fatigue properties of as sintered PM steel Fe-(1,5-2)% Mo-0,6% , tested under rotating bending , are not influenced by secondary porosity <120 μm.

Heat treatment improve the endurance limit of the batches tested .Specimens containing 1% , 10% or 100% Mo45-63 μm showed secondary pores up to 150 μm. The defects acted as crack initiation points and decreased the endurance limit .

Additional compressive residual stresses and dense 20 μm thick boundary layer which was introduced through plasma nitriding improve the endurance limit of sintered specimens from about 70%.

REFERENCES

[1**] K.D. Christian**, PhD – *Thesis* ,Troy (1990) .
[2] **T.M. Cadle –C.J. Landgraf**, *PM`90Wembley*, Vol.2 ,124 (1990).
[3] **Fa. Schenck** : Information leaflet , *Rotating beam machine "Rapid Pum"*
[4] **H.Danninger**-T. Kara : *PMI,20 9* (1988).
[5] **D. Spoljaric**- H. Danninger –B. Weiss- R. Stickler : Proc . *PM Auto `96* , Isfahan-Iran , (1996).