CONSIDERATIONS ON MICROSTRUCTURE AND MECHANICAL PROPERTIES

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Abstract: The micromechanism of carbon incorporation into the metallic powder, and the compacting of it are described. The influence of dispersed carbides on mechanical properties is evaluated together with the influence of deformation on microstructure and properties. Ductility anomalies up to the type of superplasticity, were observed at certain tensile testing strain rates. The high temperature tensile test, resistance to creep, and creep-fatigue test results are available.

KEY WORDS: microstructure, tensile deformation, strain rate, superplasticity, creep, creep - fatigue behaviour powder metallurgy.

1.INTRODUCTION

Light microscopy microstructure analysis of the produced compacts proved a high homogeneity of dispersed particle distribution in the direction perpendicular to the direction of hot extrusion. In the longitudinal direction of the bar as a result of hot extrusion the AI4C3 carbide particles were arranged into bands. Impurities like $A1_20_3$ and $FeAl_3$ particles were found in the structure. Residual, quite large carbon particles were observed after heat treatment at 450°C for 30 hours. The distance between the bands was found to be different. The matrix grain boundaries were not observable. In our previous works [3,4], we have evaluated the distance between the particles by point object simulation methods. The example of four interparticle distance categories are shown in Fig.6. This includes the mean interparticle distance the mean minimum distance X_p, the mean visibility X_v, and the mean free spherical contact distance *Xq* [1,2]

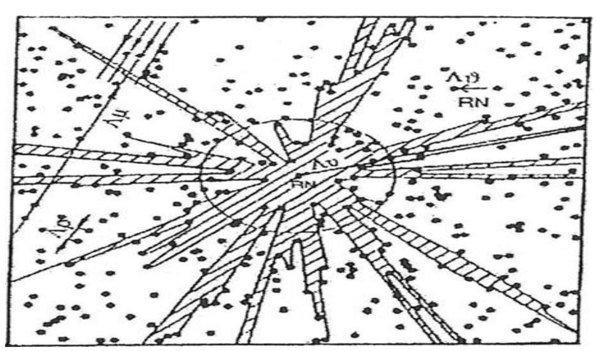

Fig 1. Interparticle distance categories arrangement of pore

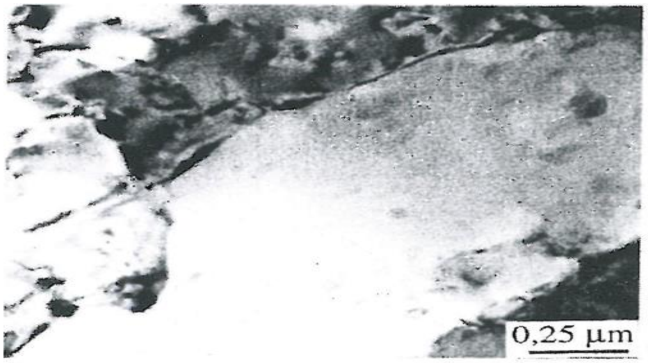

Fig.2. TEM micrograph of $A1\text{-}AI_4C_3$ with Fig. 3. TEM micrograph of $A1\text{-}A1_4C_3$ 3 wt. % carbon type I.

with 3 wt. % carbon type H

2. TECHNICAL REQUIREMENTS

With the near-constant dispersed particle grain size, the influence on strength and plasticity corresponds to the subgrain size and the mean dispersed interparticle distance. The effect of a low temperature of the heat treatment on carbide reaction, revealed more differences in structural parameters, tensile strength and elongation.

plastic properties decreased as interparticle distance *X* decreases

The data from and the results from calculations of the interparticle distance, revealed that the carbon type used in the mixing technology, i.e. by its susceptibility to milling and chemical reaction, controls the microstructure of the dispersoid. The representative substructures related to process condition are documented in Fig.2 and Fig. 3. The subgrain size can be another measure of microstructure control in the investigated material, table 1.

Table 1. Table of the characteristics of the materials tested

Materials	Composition				Density g/cm^3 min.	Elongation % min.	Tensil strength daN/mm^2	Hardness after TT
	C %	Fe%	Cu%	Other %				
FC40	0,4	Rest	-	max.2	6,95	3	18	
.FC80	0,8	Rest	-	max.2	6,95	2		
FC53	0,5	Rest	3	max.2	6,95	2	35	Carbonitridings 320
FC83	0,8	Rest	3	max.2	6,95	0,5	35	HF 320

The creep-fatigue deformation behaviour of $A1\text{-}8A1_4C_3$ dispersoid system was analysed at 400°C as well . The introduction of the cyclic stress component of various cyclic amplitude ct_a onto the creep mean stress of a_{max} showed specific influence on the lifetime of tested specimens. There was a definite increase on the time to fracture in cases of the smaller stress ratio R and for higher applied frequencies. The dependence of the strain, expressed by a specimen's elongation against amplitude ratio Q for different cyclic frequency, is shown in Fig. 16. By comparing the results with those for pure creep, the introduction of the cyclic stress component irregularly influenced the strain to fracture and resulted in a scattering of life time values depending on amplitude ratio Q and cyclic frequency, TEM micrograph, figure 4

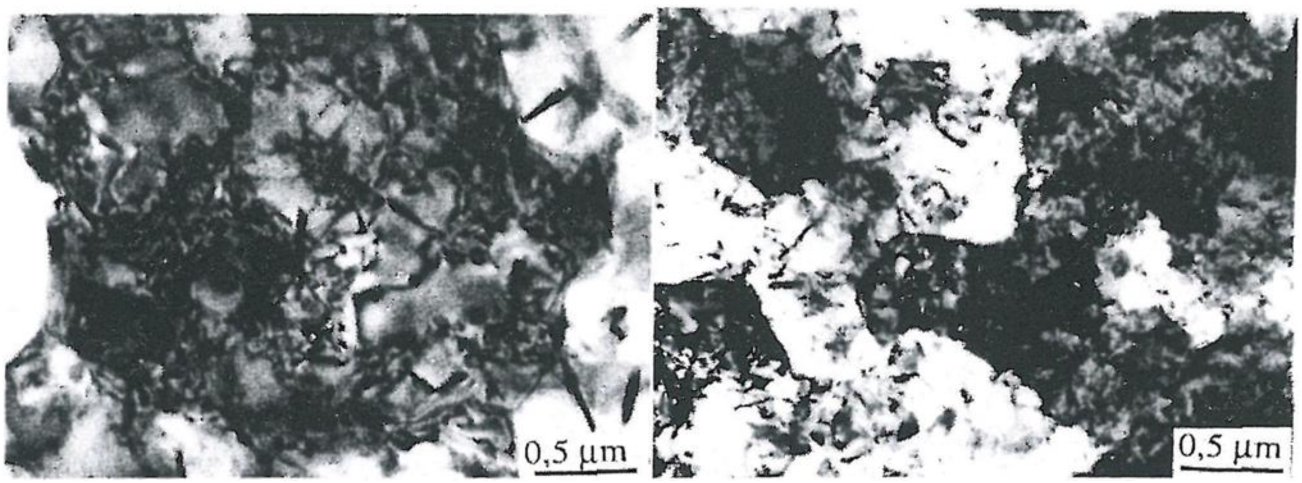

Fig.4 Breaking areas of all showing creep, s deformed substructure of A1 - A14C3

The analysis micrographic breaking areas of all specimens of MS found breaking zone porous appearance, appearance of sponge, breaking taking place at the bridges between particles. To the limit of rupture bridges to break sequentially starting breakage is dependent on the

morphology of the pores, thereby breaking is achieved in the pores, which has been shown by other authors in the literature of specalitate. Breaking is performed in areas weak bridges and large pores and areas adjacent to them, fig.4.

The analysis of the deformation mechanism by evaluation of the substructure, has confirmed the onset of polygonization process during creep. The cyclic stress component, regardless of the frequency or stress ranges, was reflected in the formation of a dislocation substructure similar to that of pure creep, Considering the fracture mechanism, corresponding to all cyclic creep tests it did not show any particular influence on fracture morphology, which might have participated either at the crack nucleation or in the time of crack propagation. Fractures were prevailingly intergranular, showing no influence of the presence of a fatigue stress component on fracture mechanis

3. CONCLUSIONS

The obtained results on the mechanical alloying process and heat treatment of A1 - C system, and on deformation behaviour of dispersion strengthened A1 - $A1_4C_3$ system prepared under different conditions, can be summarized as follows:

- Microstructure and mechanical properties showed that the best strengthening is obtained with carbon types LTD (A) and KS 2,5 (I) with a high transformation rate, high $A1_4C_3$ carbide content, and low subgrain size. On the other side, the strengthening resulted from the cracked Thermax (H) graphite is the lowest due to the low transformation rate Al + C —^ AI4C3
- The temperature dependencies of ductility, and reduction of area in temperature range of 350-450°C and strain rate of 10^{-l} $s^{'1}$, indicated a considerable increase of these properties. In a case when the volume fraction of AI4C3 changes from lower to higher, the grain rotation mechanism dominates instead of the grain boundary sliding.
- The creep mechanism is controlled by lattice diffusion.

The introduction of the cyclic creep stress component onto constant creep stress, has shown an influence on the fracture life of the dispersoid in dependence on cyclic frequency and stress ratio Q. The microstructure study proved that recovery process accompanied deformation process during creep and cyclic creep as well.

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