PROCESSES IN STRENGHENED ABOUT THE PSEUDOALLOYS

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ABSTRACT

Dispersion strengthened aluminium compacts have been prepared by powder metallurgy. The base microstructure is an aluminium matrix strengthened with dispersed ceramic particles. The strengthening is direct through dislocation movement retardation, and indirect through deformation induced by microstructure modification in the next technological steps. The method of mechanical alloying process is described. Carbon transformation to carbide AI4C3 *is characterised within different heat treatment schedules and nine commercial carbon powders tested.*

KEYWORD: Sintered materials, pseudoalloys, aluminium-graphite powder system, mechanical alloying.

INTRODUCTION

An advance in properties is sought for all materials including materials prepared by the technology of powder metallurgy. There are different ways to prepare the system matrix-dispersoid [1]. With the advent of mechanical alloying, it became possible to put the theoretical concept into practice by incorporating very fine particles, in a fairly uniform distribution, into a metal matrix. The mechanical alloying was first developed and used ,to prepare immiscible alloys and superalloys with a nickel matrix, and the method spread to other alloys later. The process starts with dry, high energy milling of the matrix powder with dispersoid, producing a homogeneous composite with a fine controlled microstructure. The intense milling is resulting in matrix with even distribution of dispersed particles. Dispersoids can be formed in a solid state reaction by introducing materials that react with the matrix in the time following heat treatment, [2,3],

A mode of mechanical alloying is reaction milling, developed for dispersion strengthened aluminium production [3, 4]. To produce aluminium dispersoid the aluminium powder is intensively dry milled with carbon powder. The transformed dispersed phase AI_4C_3 is than produced .by a chemical reaction, which starts during milling, and it iscompleted at the next heat treatment process. The resulting powder mixture is then pressed, compacted and the compacts are prepared by isostatic pressing and hot extrusion.

AI-AI_4C_3. The influence of carbide characteristics on mechanical properties is evaluated together with the influence of applied deformation mode on the microstructure development and mechanical properties.

Tab.l. Types of different carbon types used

Notation	Type	Carbon	Notation	Type	Carbon
A	ai	LTD	F	a_2	Farbruss FW 2
B	ai	Spezialschwarz 5	G	a_2	Flammruss 101
C	ai	Spezialschwarz 500	H	c	Thermax
D	ai	Printex 30	I	b	Grafit KS 2,5
E	a_2	Printex 400			

EXPERIMENTAL RESEARCH

The experimental material - dispersion strengthened aluminium with AI4C3 particles, was prepared by intense milling of aluminium powder with different types of carbon, as shown. [3]

For the nine employed types of commercial carbon system Al - $8A1_4C_3$ labelled A to I, correlations were sought between the physical and chemical properties and milling parameters, or carbide transformation rate, and properties of the produced compacts.

The different carbon types showed different distributions of carbon in the aluminium powder. Their susceptibility to milling was measured by the ability to prepare homogeneous distribution without clusters being formed. According to the obtained results the carbon forms were divided into 4 types:

a,) porous types of furnace black, made by the incomplete burning of carbohydrates at low temperatures, with very good properties. They are fine, with high contact surface, and an easy destruction of clusters.

a_2) porous types of furnace black, made by the incomplete burning of carbohydrates at higher temperatures. They are fine, but they form more stable clusters, resistant to disintegration.

b) electrographite, with a layered structure, with good susceptibility to milling, though coarse grained and with a smaller contact surface; comparable to furnace black (a,, and a_2)

c) cracked carbon, forms strong clusters, and the carbon to carbide transformation rate is low.

The milling kinetics of the system is described in more detail in reference [6]. From the results, the homogeneity of carbide distribution and contact surface area influence the Al+C transformation kinetics to AI4C3. The dependence of the transformation rate on temperature and hold time for the 4 carbon types is shown in Fig.l. The good susceptibility to transformation for porous furnace black (ai and a_2) and that of electrographite (b) is evident.

The porous carbon types are incorporated into the matrix by friction during milling, the distribution is even, and clustering is small. On the other side, hard graphite (c), resists disintegration and the granules are large as documented in F. The dependence of macro, and microhardness on carbon to carbide transition is shown-

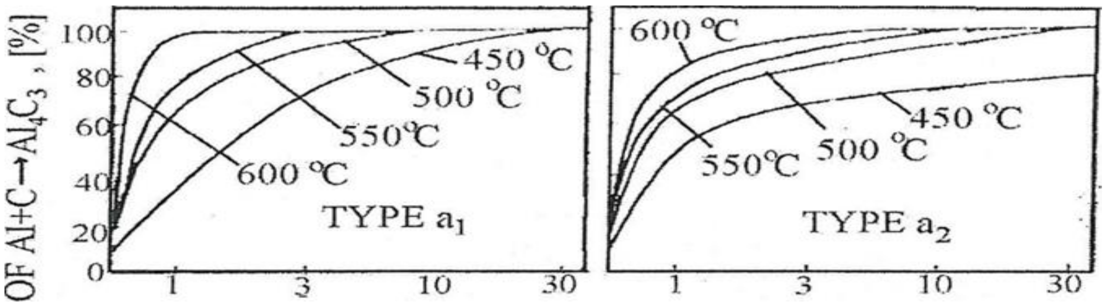

Fig.l. Dependence of carbon to the carbide transformation rate on heat treatment temperature and hold time for four carbon types

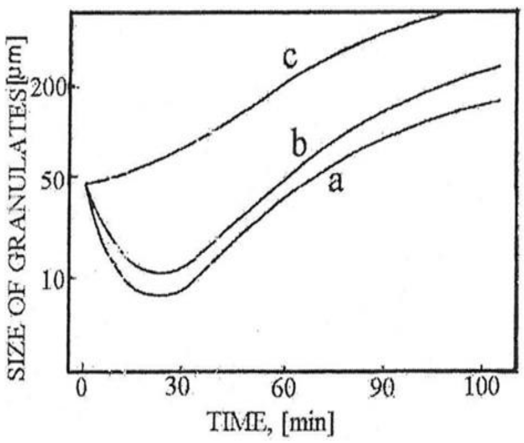

Fig.2. Mean grain size dependence on milling time and carbon type a), b), c) for A1-4A1$_4$C$_3$.

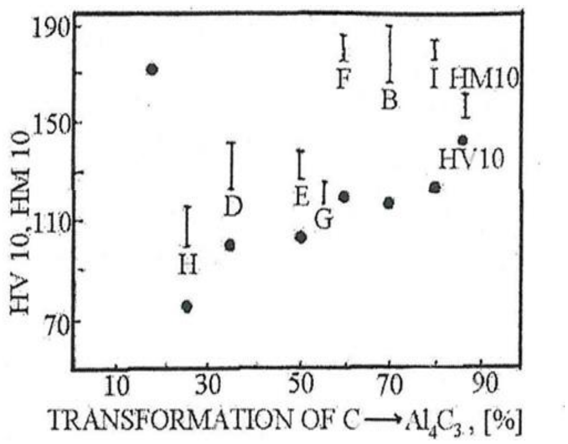

Fig.3. Dependence of macro and micro hardness on carbon to carbon transition

The maximum value of QF is equal to 1, and this value corresponds to the totaltransformation of carbon to carbide AI4C3. This value classifies the qualityof both classifies the quality of both milling and transformation hea treatment processes together. 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.Longitudinal direction of the bar as a result of hot extrusion the AI4C3 carbide particles were arranged into bands. Impurities like A1$_2$0$_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

CONCLUSIONS

The density and hardness of the pseudoalloys W-Ni-Cu obtained by the cold isostatic pressing are better than the final characteristics of the pieces released by classic technology, where the parts were pressed by uniaxial die compaction. In the same time, the powder with the fine grain-size distribution has the best results.

Microscopically, the copper diffusion is made intercrystalline or in lagoon, depending on the intergrain distances.

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:

It was shown that the transformation efficiency of carbon to $A1_4C_3$ by heat treatment of aluminium [illegible] the porous furnace black a[illegible] electrographite b) is higher, than that of the hard cracked graphite c).

REF

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- The volume fraction of carbide phase $A1_4C_3$ and the efficiency of transformation, are in good agreement with resulting microstructure and achieved mechanical properties.
- The quality factor QF is a good evaluation tool of the milling process and of heat treatment produced transformation.
- Microstructure and mechanical properties showed that the best strengthening
- is obtained with carbon types LTD (A) and KS 2,5 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 stability of properties obtained with graphite type I (KS 2,5), leads to the highest production and utilization of this type of dispersion strengthening.

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