MICROSTRUCTURE AND FRACTURE IN WC-Co SYSTEM

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INTRODUCTION

Microstructure and fracture characteristics in the system WC-Co have been studied for many years. The quantitative microstructural parameters, structural and technological defects, fracture origins, fracture micromechanisms and their influence on the mechanical properties was analysed by many authors (1-5). In spite of this fact, the fracture micromechanisms have still not been finally established in detail.

The aim of this paper is to present some results concerning the relationship between the microstructure and mechanical properties of the above mentioned system.

EXPERIMENTAL

Experiments have been carried out on the specimens WC-Co with different grain size, D_{WC} = 1.1 - 3.6 μm and different volume fraction of binder, f_{Co} = 10 - 35 %. Microstructure parameters, structural and technological defects were measured and analysed by common methods of metallography and statistical stereology. Fracture processes were studied in the connection with three-point bend strength and fracture thoughness tests by macro-, micro- and stereofractography. Statistical evaluation of individual fracture micromechanisms were studied paralelly on the fracture path and surface. In the case of WC + 6 wt.% Co with D_{WC} = 1.1 μm, the influence of the strain rate ($\varepsilon_1 = 10\ \mu m.min^{-1}$, $\varepsilon_2 = 5.10^{-1}\ \mu m.min^{-1}$, $\varepsilon_3 = 10^{-4}\ \mu m.min^{-1}$) on the Weibull modulus and mean value of bending strength was studied.

RESULTS AND DISCUSSION

On the base of numerous experiments in the system WC-Co (three-point bend test + fractography) there was possible to establish the relationship between Weibull modulus, the volume fracture of binder, the type and size of the fracture origin, FIG. 1. From experiments illustrated on FIG. 2 it is evident that the strain rate in the three-point bend test has no influence on the Weibull modulus and on the mean strength value. In this system that is probably caused by a very slow or negligible sub-critical crack growth at the room temperature.

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In determination of the fracture micromechanisms influence on the fracture toughness of WC-Co is very important to identify precisely the individual fracture micromechanisms which are taking place in the fracture. On FIG. 3 we showed the difference between the results of the analyse of fracture path and fracture surface. We have been used the results from fracture surface analysis and a good relationship between microstructural parameters, fracture micromechanisms and fracture thoughness was achieved. From the point of view of fracture toughness, the ductile rupture in the binder plays the most important role in the fracture process of this system. This is, indeed, the most discutable micromechanism of fracture (6,7). We worked out a model for the dimple rupture nucleation in the binder which is based on the dislocation mechanisms and on the local decohesion of WC/Co, FIG. 4.

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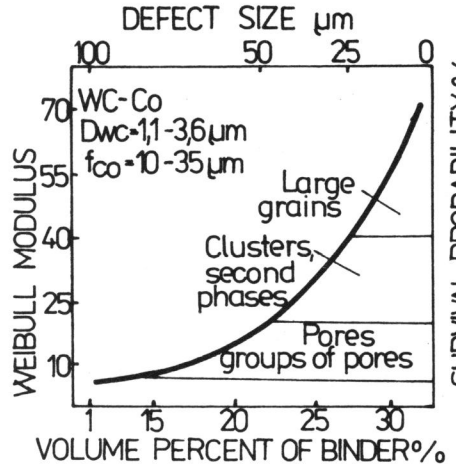

FIG.1 Relation between m, f_{Co}, defect type and size

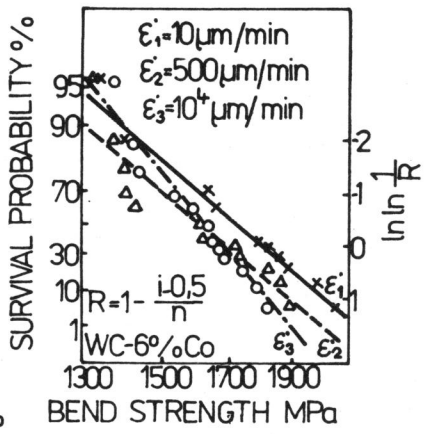

FIG. 2 Weibull diagrams at different strain rates

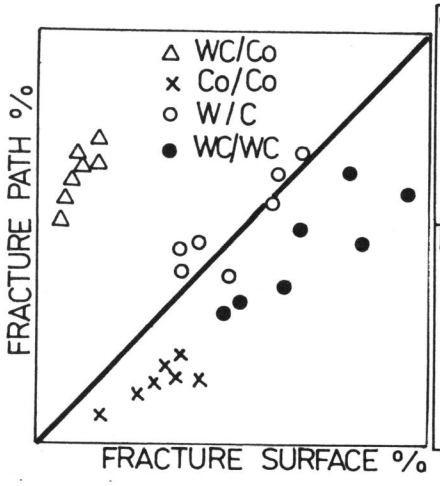

FIG. 3 Comparison of results on fracture path and surface

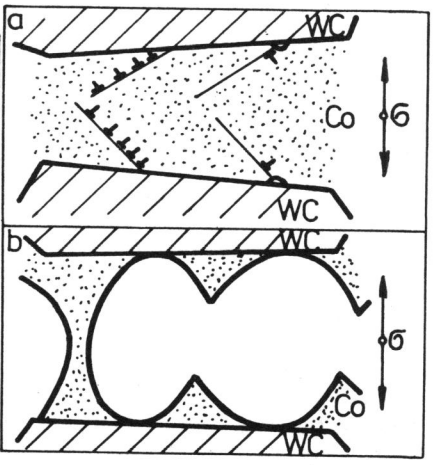

FIG. 4 Fracture nucleation in the binder