

of automotive gears was described. The results of studies of bevel gears were presented. Good correlation between porosity and wear characteristics was reported. Comparison was made with the same part made by forging.

Metal injection moulding

INJECTION MOULDING OF HARDMETALS USING AN POLYACETYL BASED BINDER

J.S. Ebenhoch, W. Hesse (BASF AG, Ludwigshafen, Germany).

Problems arising in the MIM of hardmetals were discussed, the use of a polyacetyl based binder and catalytic debinding, developed for hardmetals, was described. Properties and microstructures of injection moulded WC-Co were presented and discussed with respect to the influence of feedstock composition and process variables.

RUNNERLESS SYSTEMS FOR PROCESSING POLYMERS WITH A HEAVY LOADING OF METAL POWDER

D.J. Seres (Injection Moulding Industries, USA).

It was suggested that a high metal loading in a MIM feedstock provides a more homogeneous melt but there are also temperature losses in the feeding systems and problems in mould filling. By elimination of the runners the melt may be maintained at temperature until it enters the mould cavity. Factors influencing the design of runnerless systems were discussed.

INVESTIGATION OF INJECTION MOULDING FOR PM COMPOUND MATERIALS

K. Pischang et al (Dresden University of Technology, Dresden, Germany).

The paper presented the results of a study of Multiple Component Injection Moulding. This was used to produce a part with a layered structure. Techniques used included powder preparation by high energy milling, addition of sintering enhancers and variation of powder:binder ratios.

DEFECT FORMATION AND DENSIFICATION MECHANISMS IN INJECTION MOULDED CEMENTED CARBIDE

M.J. Yang, R.M. German (Pennsylvania State University, Pennsylvania, USA).

It was noted that MIM compacts may suffer from cracking during processing and that only some can be attributed to unsuitable process conditions. The need for close process control and a full understanding of the process was

emphasized. The investigation, which was described, explored debinding and densification mechanisms in WC-Co made by MIM. Effects of process conditions were considered.

RAPID DENSIFICATION OF PARTS TO FULL DENSITY

R.V. Raman et al (Ceracon Inc, Scaramento, California, USA).

It was reported that MIM had been combined with the CeraconTM pseudo HIP process to make fully dense near net shape superalloy parts. Effects of processing on densities and microstructures and analysis of grain boundary chemistry were described and discussed.

IMAGE ACQUISITION AND ANALYSIS DURING SINTERING AS A MEANS OF PROCESS MONITORING

D.W. Yeol (Centorr/Vacuum Industries, Somerville, USA).

An image capture and analysis system for monitoring the high temperature sintering of parts was outlined. The technique was reported to allow quantification of part size and shape during processing and correlation with process conditions. The use of the method as a real time means of control was discussed.

GRAVITY FEED METAL INJECTION MOULDING

A. Lawley et al (Drexel University, USA).

Use of MIM for production of metal or ceramic parts was discussed and problems noted. The use of gravity injection, or a system with low injection pressures, was illustrated. Experiments with steel powders and carbonyl Fe powder, with two different binders, one inert and one reactive relative to the metal powder, were carried out to determine the effects of particle size, process mode and binder type on properties and structures.

CORROSION TESTING OF METAL INJECTION MOULDED STAINLESS STEEL

M. Bulger, A. Erickson (FloMet, USA).

Application of injection moulded stainless steel parts were discussed with reference to corrosion resistance and the need to test different ways depending on the structure, austenitic or ferritic, etc. It was reported that MIM stainless steel, processed to high density, has good corrosion resistance. Test methods were reviewed and proposals for test procedures for MIM stainless steels were made. Comparisons were made between MIM and wrought stainless steels.

Composites

WEAR RESISTANCE OF A COMPOSITIONALLY GRADED TOOL STEEL

R.A. Queeney, S.F. Gradess (University of Pennsylvania, USA).

The improvements in the wear performance of tool steels by reinforcement with ceramic particles were discussed, the disadvantage being the loss of tensile and bend strength. It was reported that the use of compositionally graded or laminated materials could overcome this drawback. A study of laminated tool steels, made by PM, was described and it was reported that the compressive stresses introduced resulted in enhanced wear properties compared with simple reinforced materials.

SURFACE ANALYSIS OF DIAMOND AND IRON BASE MATRIX MATERIALS

Y-K. Wu, Y. Qing (Chongqing Non-Ferrous Metals Industry Corp, China).

An investigation of surface reactions between diamond and a Fe base matrix was described. It was reported that the reactions resulted in improved bonding when hot pressed in the range 700 to 870°C. This was attributed to reduction of surface oxides and the formation of metal carbides.

BEND PROPERTIES OF NICKEL-ALUMINA MICRO-INFILTRATED MACRO-LAMINATED COMPOSITE

A. Bose, J. Lankford (Parmatech Corp, Petaluma, California, USA).

The development of a micro-infiltrated macrolaminated Ni-Al₂O₃ composite material was described. The objective was to combine the ductility, but low strength, of the Ni with the high strength but low toughness of the Al₂O₃. It was anticipated that plastic deformation in the Ni matrix would arrest crack propagation. PM methods were used to fabricate the materials which were then subjected to bend tests.

POROUS SINTERED METAL FIBRE PRODUCTS

R. De Bruyne (NV Bekaert Sa, Belgium).

The use of metal fibres, as small as 1 µmm in diameter, as a PM raw material was discussed. It was reported that the fibres were available in a range of metals and alloys and can be fabricated alone or in conjunction with metal powders or other non-metallic fibres. Applications were said to include filter media, surgical prostheses, preforms for further processing and toughened ceramics. Structures were shown to have high porosity and permeability and solid retention capacity.