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Numerical simulation analysis of the main reason of powder-binder separation in component during PIM process

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ABSTRACT

A numerical simulation of the **powder injection moulding(PIM)** filling process was performed using the finite element analysis software ANSYS, for the no slip boundary condition employed at the wall. The numerical simulation overcomes the shortcomings of experimental measurements and provides information on the transient temperature, pressure, viscosity and velocity the effects that are difficult to measure.

For the feedstock flow round obstacles, the transient distribution and the curve of viscosity in PIM filling process are given by numerical simulation for intricate part. The pressure in the cavity heightens sharply and the pressure filed become isotonic field near the end of the filling stage, and the distribution of velocity and viscosity change rapidly accordingly. As the result of this change, the normal distribution of viscosity from boundary to the melt flowing central region is changed, which cause the distribution of viscosity at the end of the filling stage is very complicated. Based on analysis of the viscosity distribution in the cavity at the end of filling stage, the locations and possible sites of the defects such as short shots, cracks, voids, weld line and flashing along parting line can be predicted.

The results of simulation showed that with the sharp increase of pressure in the cavity, there are some small regions which viscosity is higher than that of the adjacent regions in the melt flowing central area. This may cause the powder-binder to separate or cause the density gradients in the final component. The results of study showed that the main reason of the powder-binder separation or the density gradients in the component is the sharply change of pressure near the end of filling stage. The solidification on the wall of cavity in PIM filling process doesn't increase regularly, and the thickness of layers of

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solidification is very complicated. It is difficult to analyze and predict the phenomenon by other methods, the numerical simulation of variation of viscosity is an effective method to study the phenomenon and correlative defects.

REFERENCES

[1] B. H.Rosof, The Metal Injection Molding Process Comes of Age, J.of Mater.,1989,41(8):13-16

[2] Z.S.Zheng, X.H.Qu, H.Ao. Computer numerical simulation of powder injection molding process [J]. China mechanical engineering (in Chinese). 2002, Vol.13, No.14: 1257-1260

[3] R.M. German and A. Bose, Injection molding of metals and ceramics, Metal Powder Industries Federation, Princeton, N.J., 1997

[4] Z. S. Zheng and X. H. Qu. Numerical simulation of powder injection moulding filling process for intricate parts. Powder Metallurgy 2006, 49(2):167-172

[5] Y.C. Lam, X. Chen, K.C. Tam and S.C.M. Yu, Computation Fluid Dynamics Simulation of Powder Injection Molding, PIM2000-International Conference on Powder Injection Molding of Metals and Ceramics, USA, March 20-22,2000.

[6] X.H.Qu, Numerical Simulation of Feedstock Melt Filling in a Cylindrical Cavity with Solidification in Powder Injection Molding, Trans. Of NMSC, 1998, 8 (4):544-549

[7] T. Iwai, T. Aizawa and J. Kihara. Powder-Binder Flow Simulation in Powder Injection Molding, Proc.Powder Injection Molding Symp., MPIF, (1996).

[8] T.H.Kwon, Numerical Simulation of Powder Injection Molding Filling Process for Three-Dimensional Complicated Cavity Geometries, Advances in Powder Metallurgy & Partiallar Materials, 1996, Vol.5, 19-79

[9] C.J.Hwang and T.H.Kwon, A Full 3D Finite Element Analysis of Powder Injection Molding Filling Process including Slip Phenomena , Polymer Engineering and Science , Vol. 42, No.1, 33-50,(2002).

[10] C.J.Hwang and T.H.Kwon, Finite Element Analysis of PIM Filling Process with Slip Characterization of Powder-Binder Mixtures, Journal of the Japan Society of Powder and Powder Metallurgy, Vol. 46, No. 8, pp.837-843 (1999).

[11] F.Lin, Z. S. Zheng and X. H. Qu. Numerical Simulation of PIM Filling Process Based on Second Development of ANSYS, Computer Engineering and Applications, 2005, 41(3):194-197

[12] V.V.Bilovol,L.Kowalski and J.Duszczyk. Modelling of transient temperature fields during filling stage of Powder Injection Moulding. Powder Metallurgy, 2000,43(3):228-232