UNIVERSITI TEKNOLOGI MARA

DEVELOPMENT OF METAL INJECTION MOLDING (MIM) BINDER FORMULATION OF 17-4PH STAINLESS STEEL POWDER

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for the degree of
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I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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ABSTRACT

Metal injection molding (MIM) process is drawing much attention as a promising technique which leads to a large scale production of metalworking with precision and complex in shape. It is an elegant blend of metal injection molding, based on the use of fine metal powder particles mixed with waxes and/or thermoplastic polymers to form a feedstock that can be molded. The granulated feedstock is then given a shape using an injection molding machine. After shaping, the polymer binder must be removed from the molded part without significantly disturbing the powder particles. Then the powder is sintered at high temperatures, often to near theoretical densities. This technology provides an alternative method for producing small, complex, precision parts, cost effectively in high run volumes. In current study, the 17-4 PH stainless steel powder with the median particle size of 17.5μm has been chosen as a model materials mixed with the locally biopolymer binder. Four binder compositions consisting of polyethylene (PE), paraffin wax PW), palm stearin (PS), thermoplastic natural rubber (TPNR) and stearic acid (SA) then formed PS/PE, PS/TPNR, PW/TPNR and PW/PE/SA binder system. These formulations were mixed at 160°C using a Z-blade mixer for two hours to prepare the feedstock. Pseudoplastic behavior that suitable for homogeneous molding was achieved at all feedstock formulations. This versatile, organic locally binder system is cheaper, safe in practise, environmental friendly and present fewer health hazards to employees and environment during processing of metal components. The optimum powder loading used in this study is 65 vol. % based on the result of powder loading analysis that is 68.68 vol. %. Feedstock completely filled the mold cavity at a molding temperature of 220°C then the green body was soaked in heptane solution to remove soluble binder. Before sintering, thermal debinding took place to remove remaining binder left. Results show that the heating rate of 1°C/min during thermal pyrolysis is the best because no blotting or surface defects spotted at the specimens. Four sintering temperatures were carried out that are 1320°C, 1340°C, 1360°C and 1380°C. The density of parts sintered at 1380°C achieved 97% of theoretical value. PS/TPNR binder show the excellent tensile strength of 853 MPa while other binders agree with Standard MPIF-35. Therefore, hardness test also shows that PS/TPNR leads. However, increment of sintering temperature to 1380°C resulted in decreasing in hardness value. This due to materials tend to be brittle. In future, that is worthwhile investigating the heat treatment of the specimen whether improvement on the physical and mechanical properties could be achieved.

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