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Mechanical Properties of Sintered PIM Test Specimens

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Abstract. This paper deals with the mechanical properties of test specimens of commercially available PIM feedstock based on stainless steel powder. A part of the polymer system has been removed in water. This process was followed by thermal removal of residual binder in a furnace, and in the last step the specimens were sintered at high temperature. For the production of samples was used untreated and recycled feedstock. The aim was to determine the effect of thermal stress during processing on the final mechanical properties.

Introduction

A new technology known as powder injection molding (PIM) uses the shaping advantages of injection molding but is applicable to metals and ceramics [1]. This idea has origins in the 1930s when automotive ceramic spark-plug bodies were fabricated using thermoplastic binders. PIM concept excites most design engineers, especially when they learn the final properties are the same as with other metalworking processes [2].

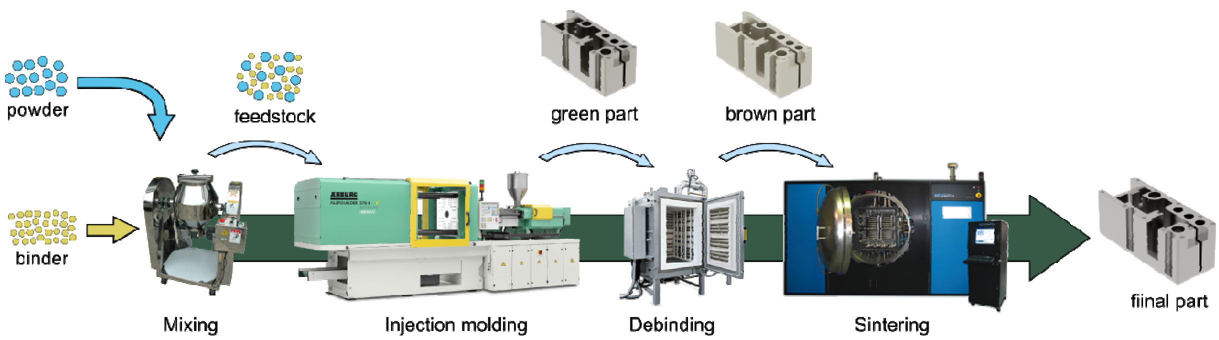

Fig. 1. Processing steps in PIM technology.

PIM is essentially a four-step process as is shown in *Fig. 1* and involves [3]:

- preparation of feedstock from powder and binder;
- molding a feedstock into mold cavity;
- removal of the polymer binder;
- thermal process which decompose the remaining polymer binder and sinter the powder to compact product.

Experimental Part

Tensile test specimens has been produced by injection molding using commercial available feedstock specified as 17-4PH. Feedstock was processed as new from supplier, and recycled – heat treated by previous injection molding. Design of mold cavity is illustrated on *Fig. 2*.

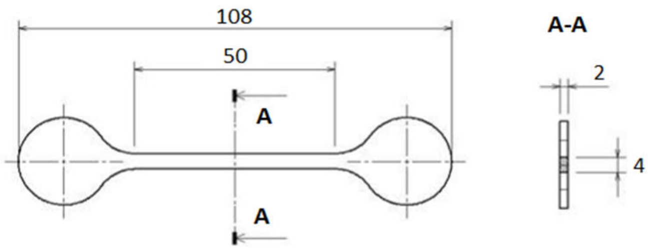

Fig. 2. Dimensions of mold cavity.

As an injection molding machine has been used Arburg Allrounder 370 S (Germany). Nozzle temperature has been set on 205 °C and mold temperature to 50 °C.

After molding the polymeric binder has been removed in aqueous solution of water and corrosion inhibitor having a temperature of 60 °C for 8 hours. Debinded and dryed parts have been pre-sintered in pure hydrogen atmosphere at 600 °C (temperature ramp 3 °C / min, 2 hour holding) and fully sintered at temperature 1 360 °C (temperature ramp 5 °C / min, 2 hour holding). Each material has been sintered in separate batch.

Table 1. Tensile test properties of 17-4PH (new and recycled material).

	17-4PH - new			**17-4PH - recycled**		
	$\bar{x}$	s	v	$\bar{x}$	s	v
E [GPa]	**170.7**	22.0	12.9	**99.5**	22.4	27.6
Rp [MPa]	**554.0**	46.2	6.9	**537.1**	20.7	3.9
Rp (0,2 %) [MPa]	**265.6**	18.5	8.3	**252.1**	18.1	7.2
Δ L [%]	**7.4**	1.3	17.3	**7.0**	0.9	12.7

Conclusions

In this paper the following results has were obtained:

1. An Arithmetic mean of Young’s modulus of recycled materials decrease by 42 % in case of 17-4PH.
2. The value of an arithmetic mean of ultimate strength decreased slightly. While the strength of new material was 554 MPa, recycled material strength was 537 MPa.

This work has demostrated the effect of previous thermal treatment of material on the final product’s tensile properties. Recycled material has worse elastic properties than new material.

References

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