cbecimat26
26° Congresso Brasileiro de Engenharia e Ciência dos Materiais
22 a 26 de novembro de 2026
Costão do Santinho
Florianópolis-SC

EVALUATION OF THE ADDITION OF DUCTILE IRON MACHINING CHIPS IN COMPONENTS MANUFACTURED BY CONVENTIONAL POWDER METALLURGY

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INTRODUCTION

Conventional powder metallurgy (PM) enables near-net-shape production with low material waste. Reusing ductile iron (SGI) machining chips as a secondary feedstock supports circular manufacturing, but their irregular morphology and limited compressibility can alter densification and mechanical performance.

OBJECTIVE

Evaluate how 5–25 wt.% SGI chips added to commercial iron powder influence compaction, sintering, porosity, microstructure and compressive behavior.

MATERIALS & METHODS

1 RAW MATERIALS
ASC 100.29 Fe + SGI chips
5, 10, 15, 20, 25 wt.%

2 BLENDING
PM-100, 250 rpm, 10 min
1 wt.% zinc stearate

3 COMPACTION
Uniaxial, 400–800 MPa
15 s; Ø 13 mm specimens

4 SINTERING & TESTS
1165 °C / 15 min, N_2/H_2 60/40
OM, ImageJ, density, compression



As-sintered specimens (from left: 5, 10, 15, 20 and 25 wt.% SGI).

DENSIFICATION BEHAVIOR

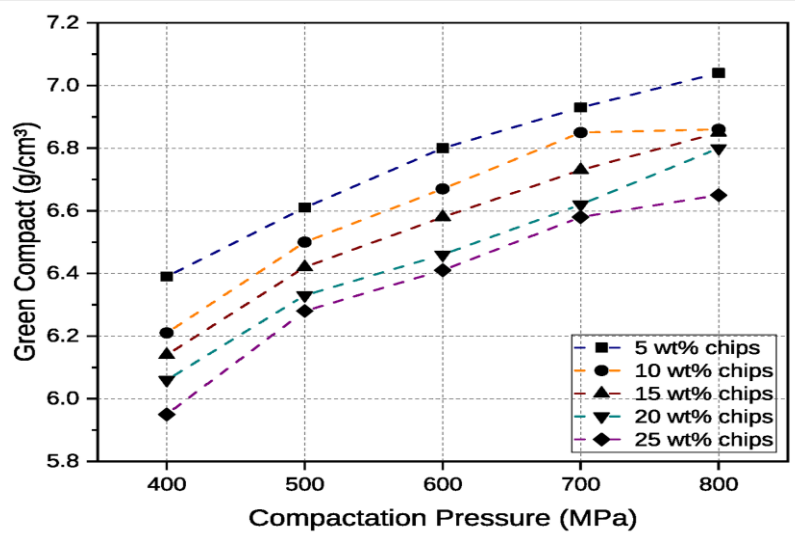


Figure 1. Green density versus compaction pressure.

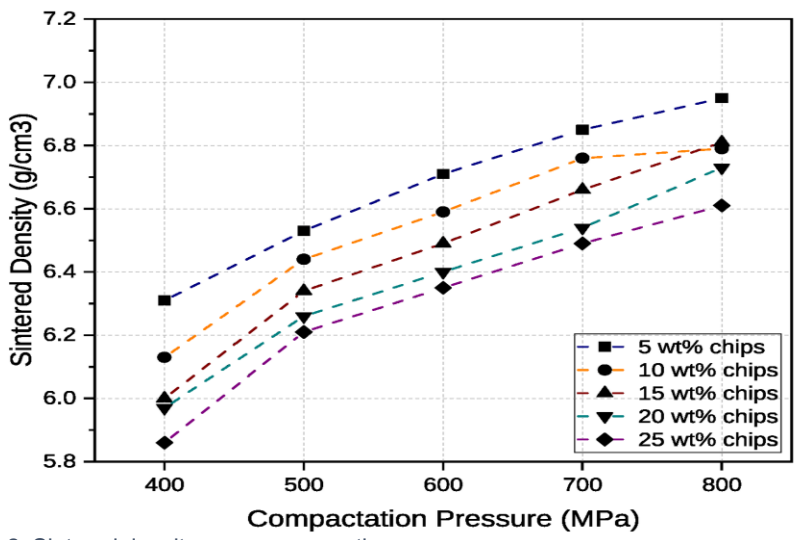


Figure 2. Sintered density versus compaction pressure.

RESULTS & DISCUSSION

Higher compaction pressure increased density for all mixtures, whereas increasing chip content lowered green and sintered density. At 700 MPa, sintered density decreased from 6.85 to 6.49 g/cm³ between 5 and 25 wt.% SGI.

POROSITY MIN. 6.38% — 15 wt.% SGI

PEAK TRUE STRESS 531 MPa — 25 wt.% SGI

INCREASE ~24% — vs. 5 wt.% SGI

MICROSTRUCTURE & POROSITY

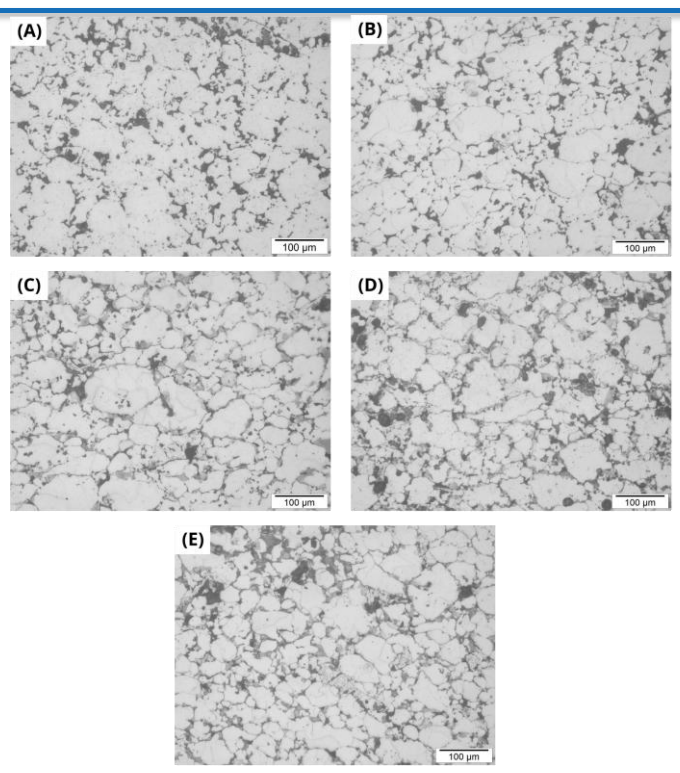


Figure 3. Optical micrographs: (A–E) = 5–25 wt.% SGI; 100 µm scales.

Ferritic–pearlitic regions and persistent pores reveal heterogeneous microstructures. Image-based porosity was non-monotonic, with its lowest value at 15 wt.% SGI.

COMPRESSION RESPONSE

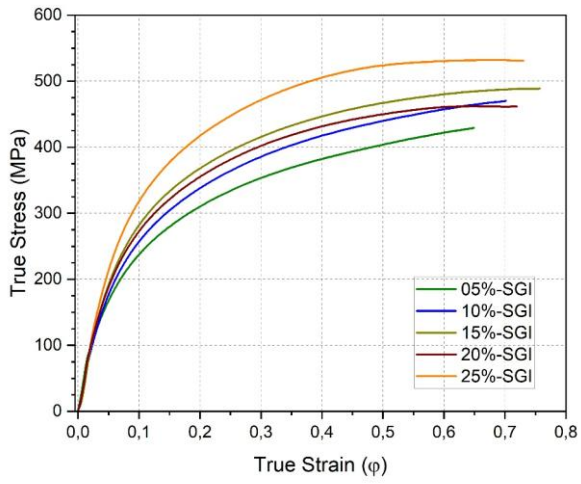


Figure 4. True compressive stress–strain curves (5–25 wt.% SGI).

CONCLUSIONS

01 SGI chips can be incorporated into iron parts using a conventional press-and-sinter route.

02 Higher chip fractions restrict densification; elevated compaction pressure partly mitigates the effect.

03 15 wt.% SGI provided the lowest measured image porosity (6.38%).

04 25 wt.% SGI reached 531 MPa maximum true compressive stress, despite its lower density.

REFERENCES & ACKNOWLEDGMENT

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Acknowledgment: LdTM / UFRGS – laboratory facilities and research infrastructure.