



Article

Printability Metrics and Engineering Response of HDPE/Si₃N₄ Nanocomposites in MEX Additive Manufacturing

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S1. 3D printing settings, geometry of the samples per test and infill structure

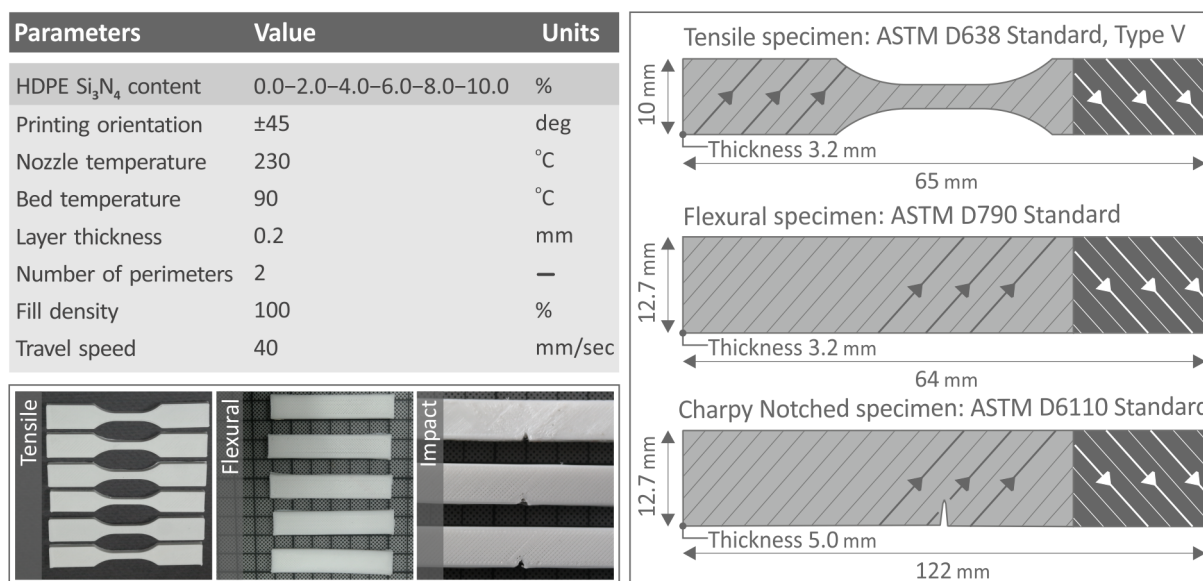


Figure. S1. Applied settings for the 3D-P of the specimens, pictures from the tensile, flexural and impact 3D-P specimen samples, as well as the designed models of those specimens with their dimensions and respective ASTM international standards.

S2. Thermal investigation

TGA and DSC were used to assess the thermal characteristics of HDPE/Si₃N₄ samples. A Diamond Perkin Elmer (Massachusetts, USA) device was selected for the TGA with a temperature cycle of 40–550 °C and a rate of increase of 10 °C / min. A Discovery Series DSC-25 DSC calorimeter (TA Instruments, Delaware, United States) was used to conduct the DSC, with an RSC-90 Refrigerated Cooling System. The working conditions during the TGA and DSC analyses were an inert environment of high-purity N₂ (nitrogen gas).

S3. Rheometric analysis

A DHR-20 Discovery Hybrid Rotational Rheometer (TA Instruments, Delaware, USA) was employed for the rheometric investigation (ASTM D1238-13, for MFR). An Environmental Test Chamber (parallel-plate setup for temperature regulation) was used in the rheometric analysis. The acquisition duration was 10 seconds for the measured points to prevent excessive heating and decomposition. Both MFR and rotational rheometric tests were conducted to assess the flow rates of the materials at selected temperatures and preselected pressures.

S4. μ -CT scan

The porosity percentage and dimensional deviations of the 3D fabricated samples were evaluated through microcomputed tomography (μ -CT) scans. A Tomoscope HV Compact 225 kV Micro Focus CT-scanner from Werth Messtechnik GmbH located in Giessen, Germany, accompanied by a 1024×1024 -pixel sensor was used, alongside a software named VG Studio MAX 2.2 from Volume Graphics GmbH, Heidelberg, Germany, for data analysis. A 75 L setup with a resolution of $72.58 \mu\text{m}$ on the X-axis and $72.65 \mu\text{m}$ on the Y-axis was used for the dimensional accuracy measuring. A 16 L setup with resolution $15.46 \mu\text{m}$ on the X-axis and $15.49 \mu\text{m}$ on the Y-axis, was used for the porosity measuring. Both included 1600 sections/ revolution.

S5. Raman peaks

Table S1. Significant Raman peaks and their corresponding assignments for pure HDPE.

Wavenumber (cm^{-1})	Intensity	Raman peak assignment
1063	Medium	C-O-C stretching [1]
1131	Medium	C-O-C stretching [2]
1297	Medium	C-O-C stretching [1]
1418	Small	CH_3 deformation [1]
1441	Small	CH_2 deformation [1,3]
2850	Major	CH_2 symmetric stretching [4]
2883	Major	C-H antisymmetric stretching [5]

S6. Summary of the main experimental findings

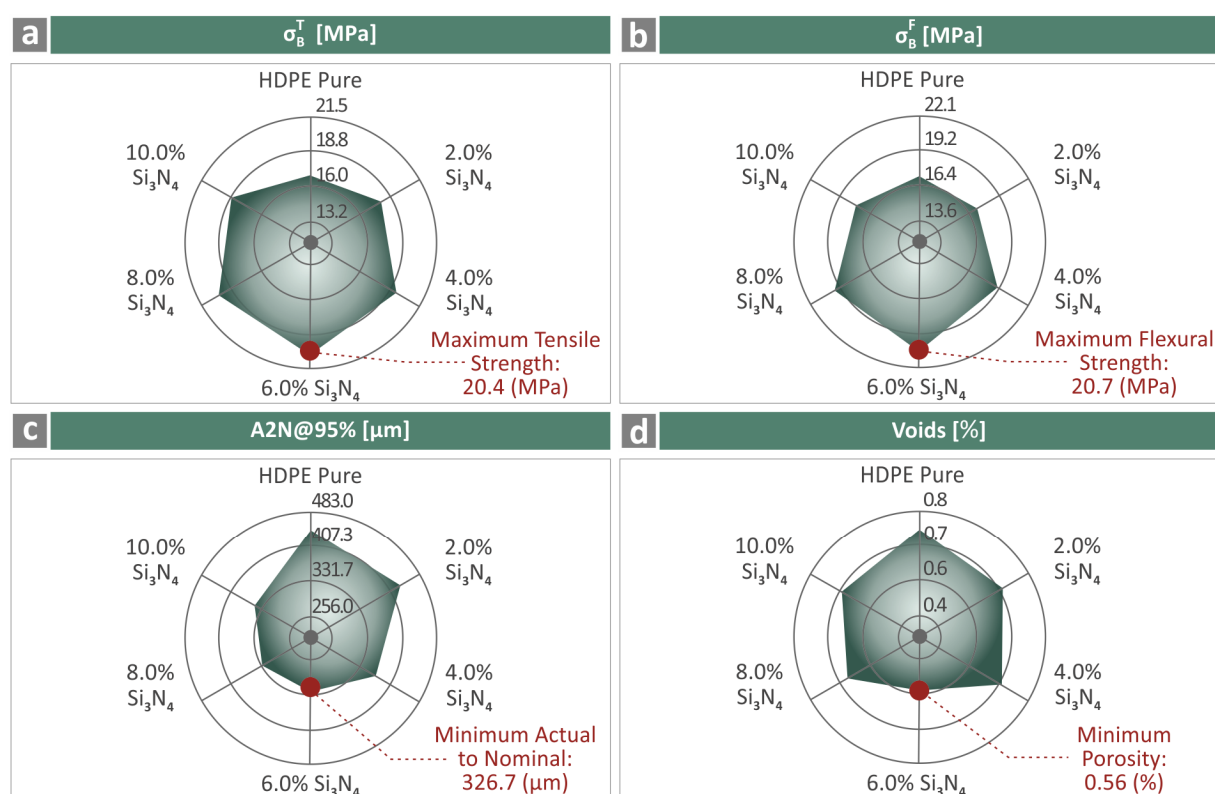


Figure S2. The results from all the HDPE/ Si_3N_4 0.0, 2.0, 4.0, 6.0, 8.0 and 10.0% tested samples regarding their (a) tensile strength, (b) flexural strength, (c) A2N@95% and (d) voids percentage, gathered in four spider-shaped graphs.

References

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