

SPT323 - Material Comparison - Testing and Results

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Compare and Contrast:

Comparing the BASF 316L stainless-steel against the zinc-coated stainless-steel, the results were very stark. Not one of the 316L SS bolts survived testing; each sheered at the nut connection. Whereas the ZC-SS bolts did not experience catastrophic damage and in fact did not have any thread damage.

Furthermore, peak torque results were different than expected. I did not expect the 316L SS bolts to do well at all because of their clay-like nature and not having gone any post-processing treatment. However, they were able to withstand some level of torque. In the end, the 3D printed fasteners performed more like M5 bolts rather than the M6 bolts they were designed after. However, I am pleased to note that the bolts did overperform comparable nylon bolt results.

Touching on price, the 316L SS bolts are about 30x more to fabricate compared to traditional ZC-SS fasteners. This makes the bolts extremely expensive. They also did not perform anything close to the ZC-SS.

Test Results:

Material	Yield Strength	Ultimate Tensile Strength	Young's Modulus	Hardness (Vickers Hardness)	Ductility	Fatigue	Cost per Unit Mass	Estimated Weight of Prototype
ZC-SS	510 MPa	555 MPa	190 GPa	900 HV10	60-70%	240 MPa	\$0.00068/gram	~5-20 grams/unit
BASF 316L	251 MPa	561 MPa	190 GPa	128 HV10	60-70%	146 MPa	\$0.17/gram	~3-15 grams/unit

Final Thoughts:

Practicality

- Metal-composite fasteners do succeed in a few ways
 - Faster manufacture
 - Ease of accessibility
 - High quality/fine threads
- Stronger than traditional polymer fasteners
 - M6x1.0 Nylon Bolt Peak Torque = 1.83Nm.
- With post processing, possibly as strong as SS bolts
- Best use cases for custom fasteners, quick replacements requiring stronger-than-polymer values, locations where commercially available bolts are not able to be obtained.

Improvements for next time

- Post processing would most likely yield better results
- More accurate gauge would provide higher quality results
 - Gauge kept resetting, losing zero point with such low values
- Better test rig would allow for ZC-SS fastener peak torque findings