

G3Si1

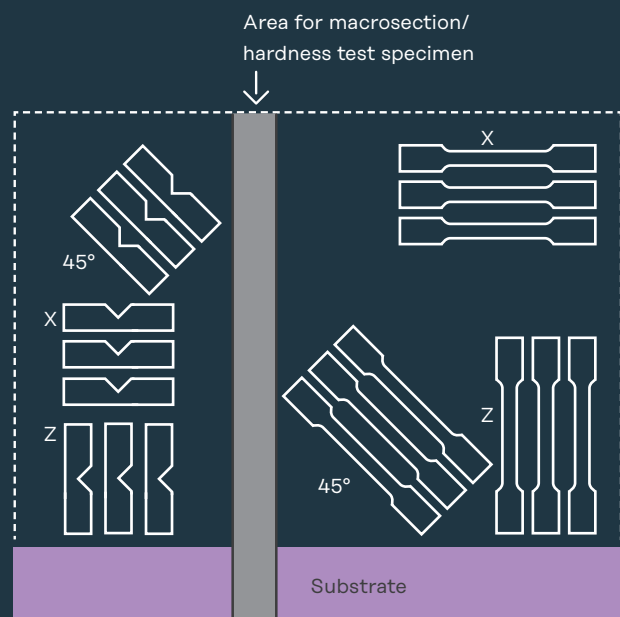
Additive manufacturing

Summary

Wire and arc-based additive manufacturing is a revolutionary way of manufacturing products, whereby the welding wire — which is melted by the arc — is applied additively in layers. To investigate the mechanical-technological properties of additively manufactured components, tests were conducted on three different wall thicknesses:

- Minimum wall = the thinnest possible wall that can still be solidly welded.
- Medium wall = the average wall thickness value of the thin and thick wall.
- Maximum wall = the maximum wall thickness that can be produced with a continuous weld pool.

In order to identify anisotropic properties, three test specimens were taken from a wall in three different directions respectively (x, 45°, & z).



Result:

The material properties are not negatively affected by the additive manufacturing process. The research has shown that the mechanical and technological properties of comparable standard materials are met in full.

Determined mechanical- technological properties (as welded)

	Standard specification Filler material ISO 14341-A	Untreated, welding condition M21	Stress-relief heat treated, 600 °C/2h M21	\bar{x} = average value σ = standard deviation	Minimum wall 5 mm			Medium wall 15mm			Maximum wall 25 mm		
Tensile test per ISO 6892-1 Test specimen geom- etry per ISO 50125/E 3x8x30					X	45°	Z	X	45°	Z	X	45°	Z
Yield point Re/Rp0.2 [MPa]	≥420	440*	380*	\bar{x}	431.95	437.79	430.47	438.15	426.64	430.66	411.15	406.40	396.70
				σ	12.88	13.49	14.14	13.19	14.62	8.99	12.69	9.82	15.09
Tensile strength Rm [MPa]	≥500-640	560*	490*	\bar{x}	527.87	536.83	529.09	514.56	529.65	524.07	500.45	503.72	499.87
				σ	11.00	13.36	9.97	3.07	7.08	2.49	3.52	3.61	3.61
Elongation at fracture A ₅ [%]	≥20 (L0 = 5d0)	30	30	\bar{x}	28.28	25.42	27.10	32.60	27.22	27.37	31.15	30.05	31.28
				σ	4.33	2.97	4.27	0.55	1.56	0.43	2.96	2.49	2.02

Notched bar impact test per ISO 148-1

The values were determined on a ¼ test specimen and converted to a full test specimen. Notch impact with V-notch. Standard specification -40 °C

Impact energy [J]	≥47	80*	-	\bar{x}	117.67	123.25	124.41	122.21	124.61	123.11	116.57	120.56	119.80
				σ	3.22	3.59	3.44	7.81	3.49	8.37	2.52	2.56	4.38

Hardness per ISO 9015-1

Hardness value HV5	160 ±10						160 ±10			160 ±10			
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Porosity per ISO 5817

Porosity [%]	<0,01%						<0,02%				<0,01%		
max. pore size [mm]	-						0,05			0,01			

*acc. to manufacturer

Other information:

deposition rate (Øw = 1,2 mm): ~ 3 kg/h