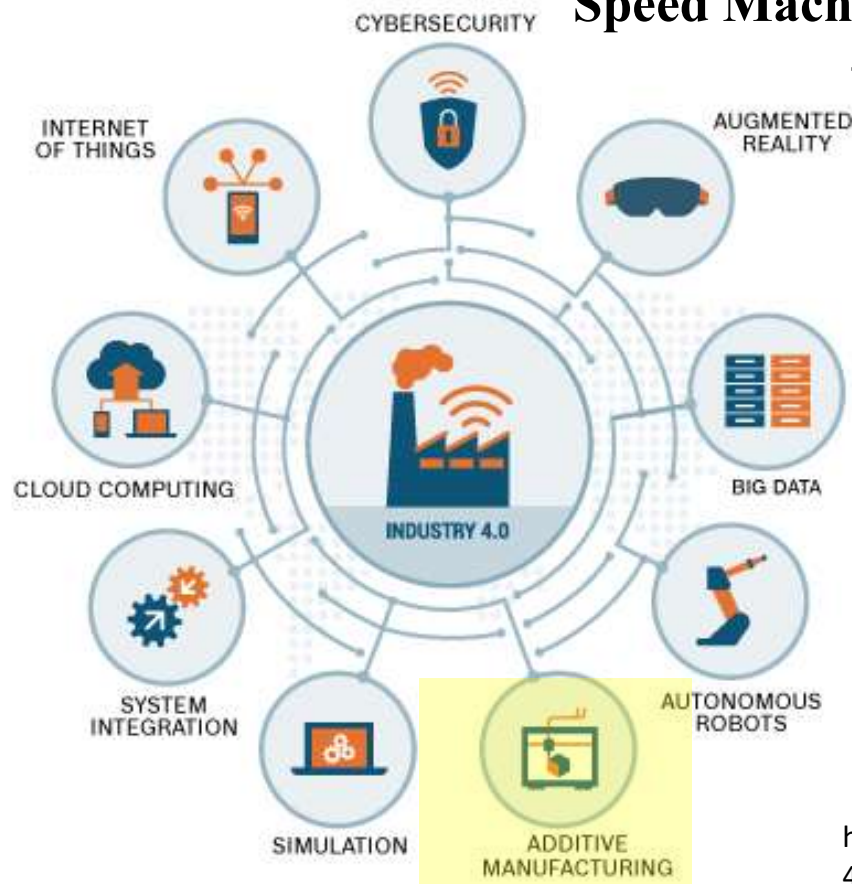
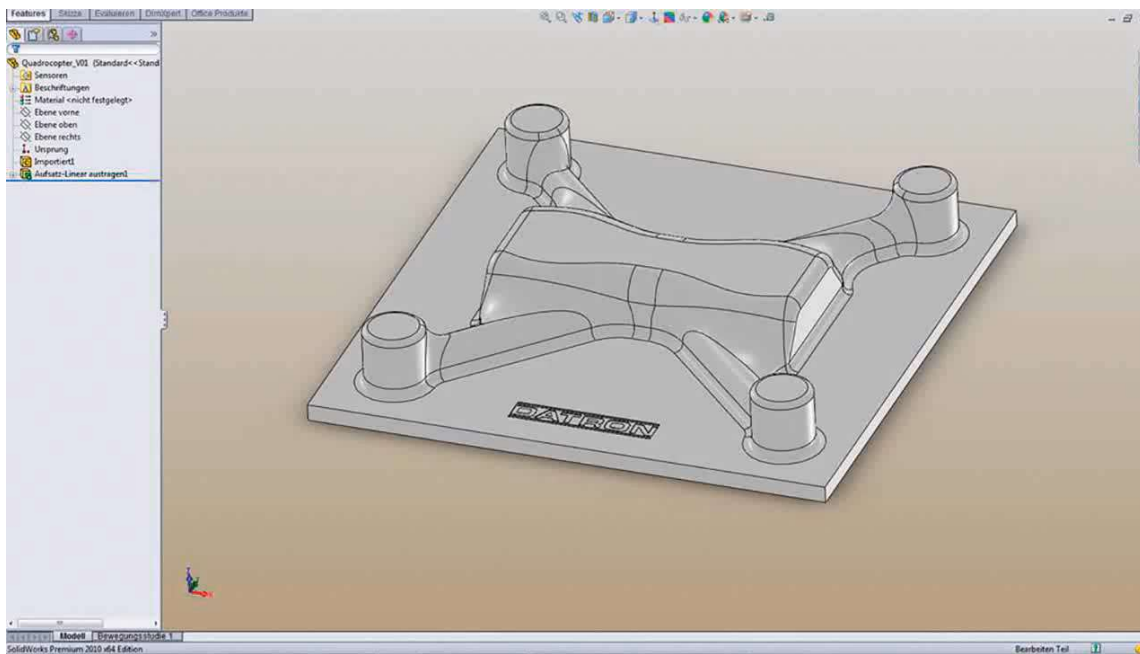

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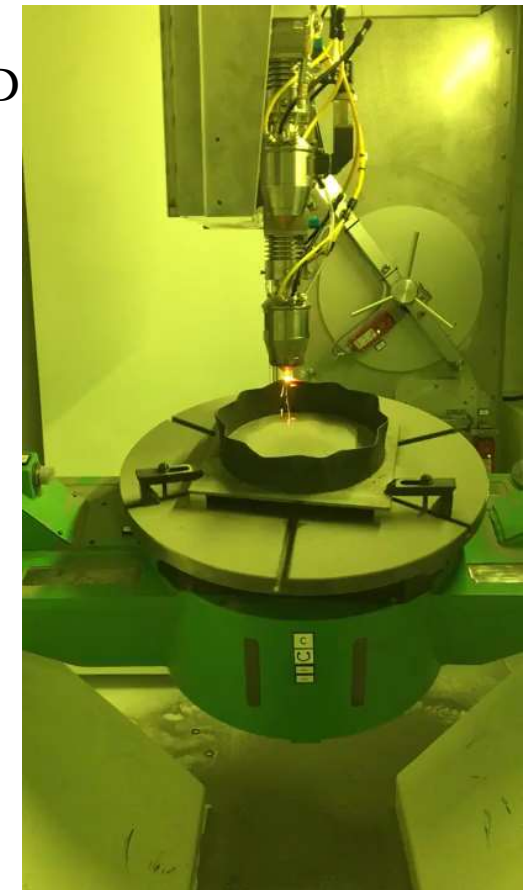
Professor Reginaldo T. Coelho, PhD
rtcoelho@sc.usp.br

Subtractive Processes

Additive Processes – 3D printing



Initial simple shapes and remove material



Build a 3D real piece 2/11

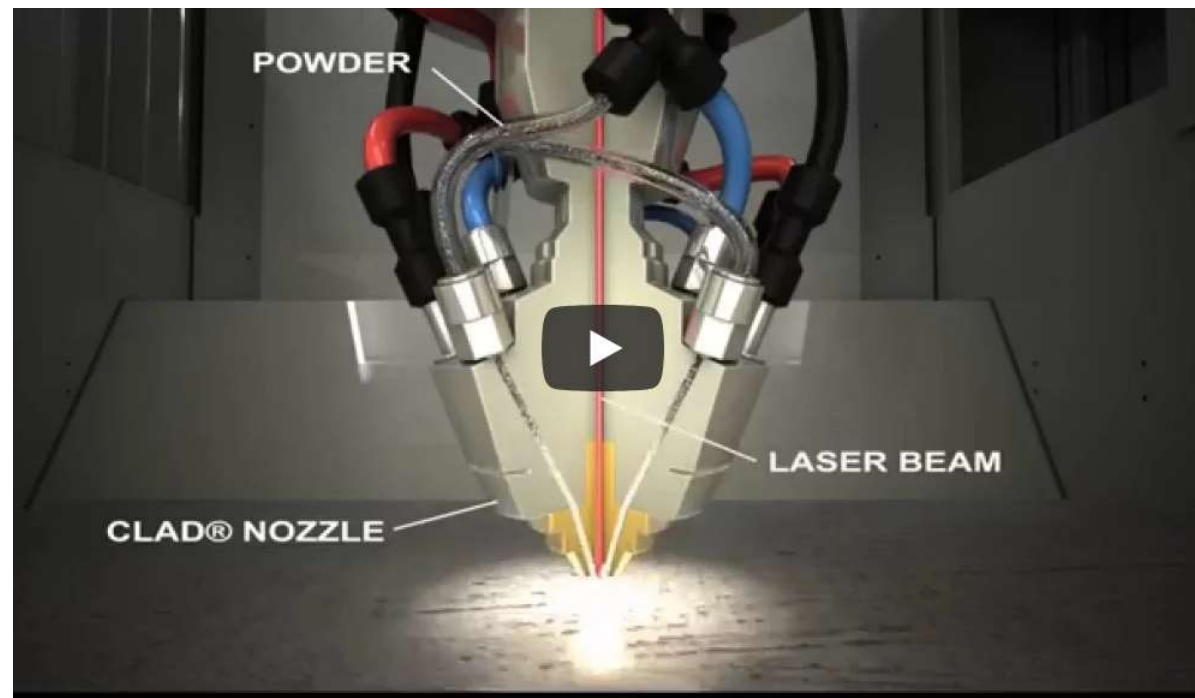
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D.E.D. – Direct Energy Deposition



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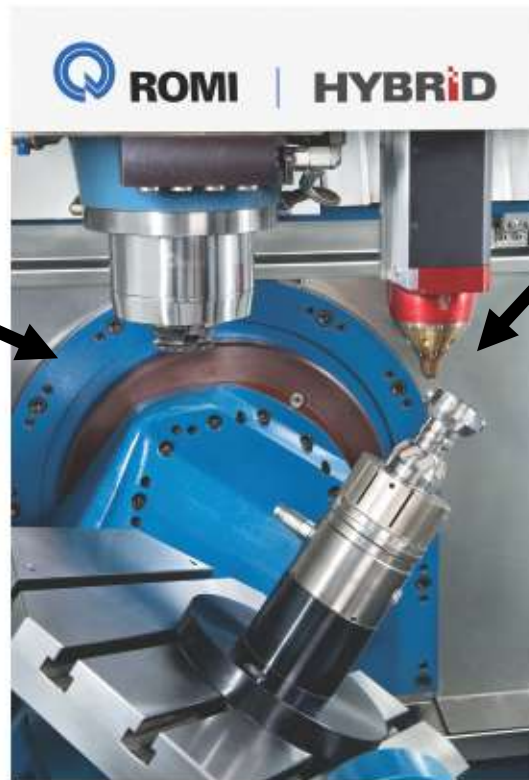
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HYBRID PROCESSES

Machining
Tools
(Subtractive)

Additive
Manufacturing
(AM) Tool



Additive Manufacturing (AM) + Machining/Grinding (HSM/G)

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What can be made using HYBRID 3D printing?



<http://www.todaysmedicaldevelopments.com/article/renishaw-additive-manufacturing-orthopedic-implants/>



<https://www.plasticstoday.com/injection-molding/optimized-part-design-workflow-structural-injection-molded-parts/213494898744357>

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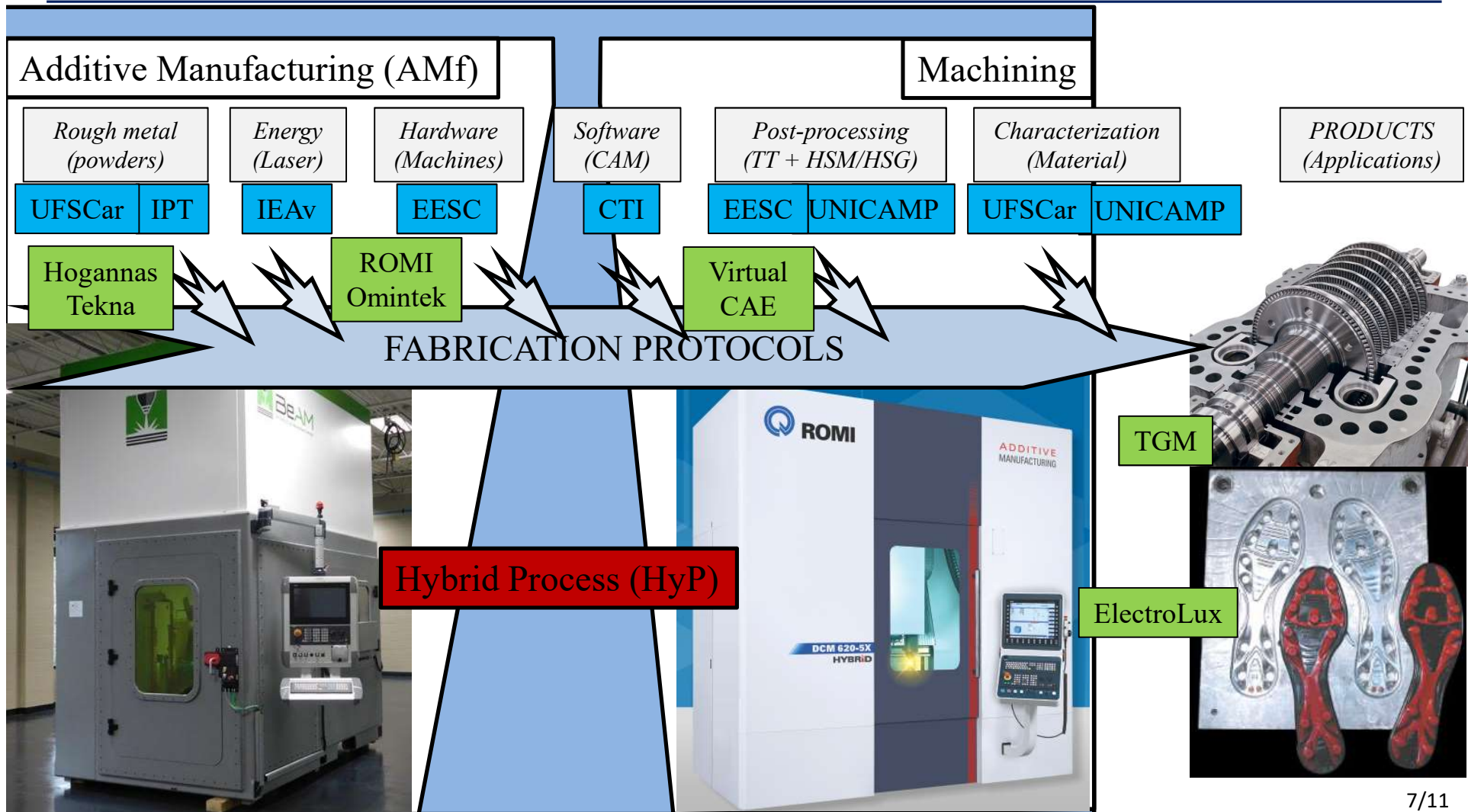
Can we 3D-print metals now?

- Perspectives:
 - FGM materials
 - Repairs
 - Higher deposition rates
 - Making complex parts
- Problems:
 - Material Integrity
 - Surface quality
 - Dimensional and Geometric precision

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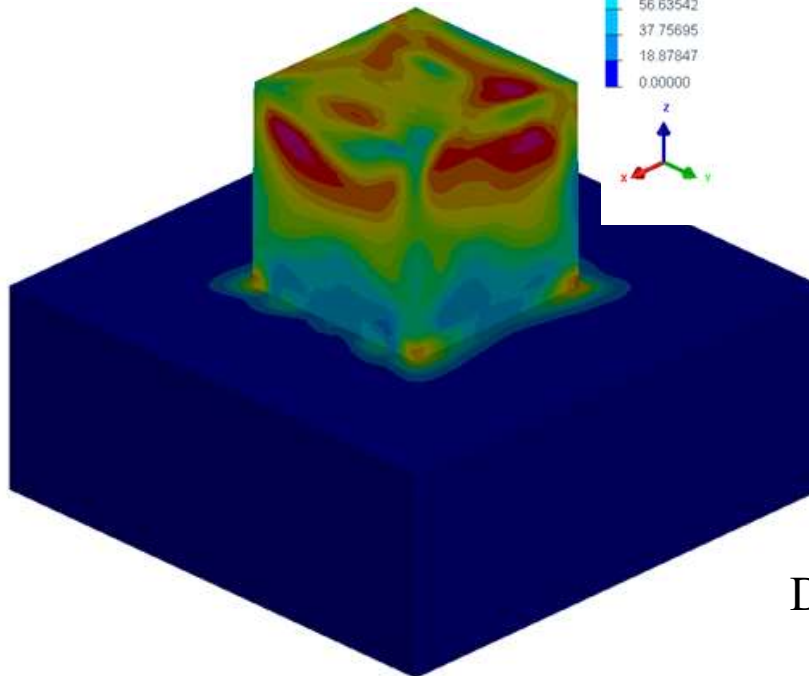
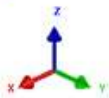


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Theoretical simulation

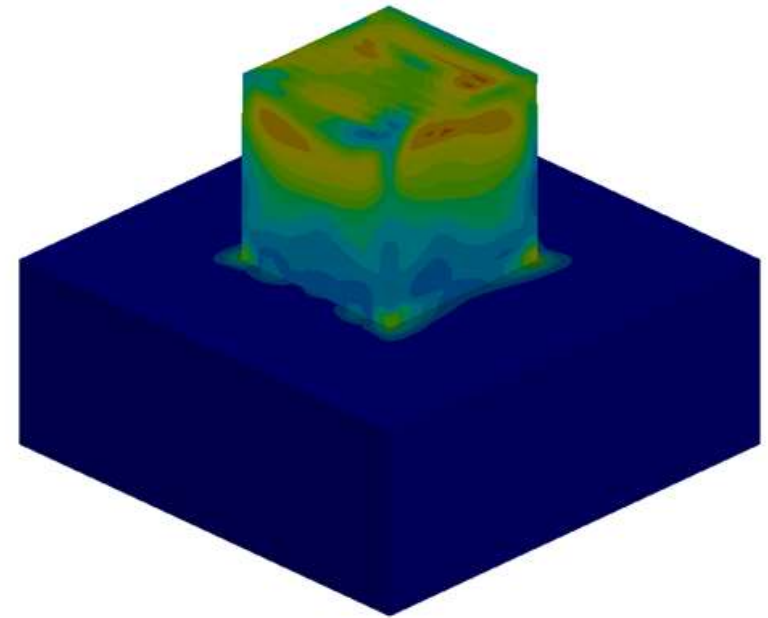
DESI2
Stress : Stress Von Mises
Min = 0.00494055 at Ele 51000
Max = 130.079 at Ele 51697

132.28584
123.46679
114.64773
105.82868
97.00962
88.19056
79.37151
70.55245
61.73339
52.91434
44.09528
35.27623
26.45717
17.63811
8.81906
0.00000



DESI2
Stress : Stress Von Mises
Min = 0.00298619 at Ele 50951
Max = 257.581 at Ele 60147

283.17709
264.29861
245.42015
226.54167
207.66319
188.78473
169.90625
151.02779
132.14931
113.27084
94.39236
75.51389
56.63542
37.75695
18.87847
0.00000

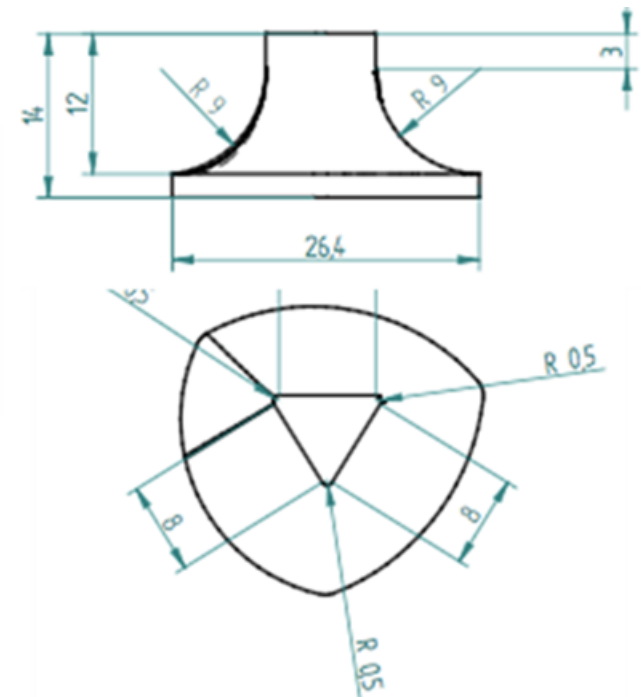
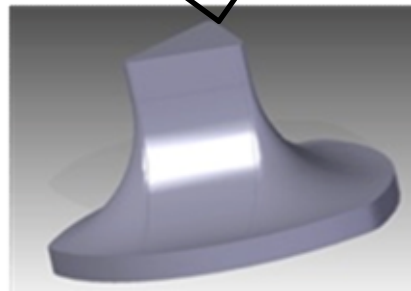
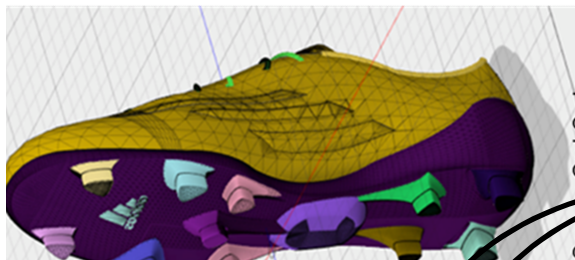


Deposition at 35 °C

Deposition at 500 °C

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Example: An Injection mold for a Football boot

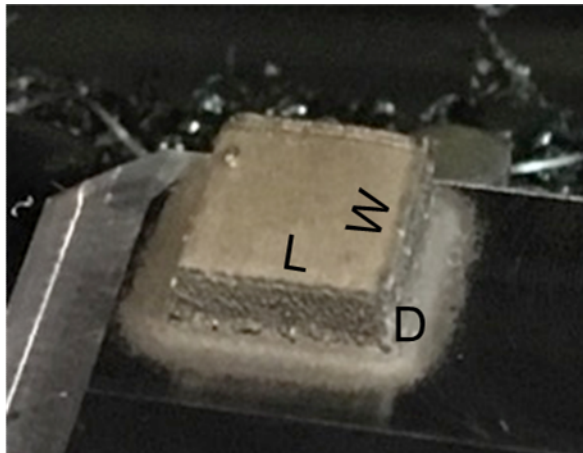


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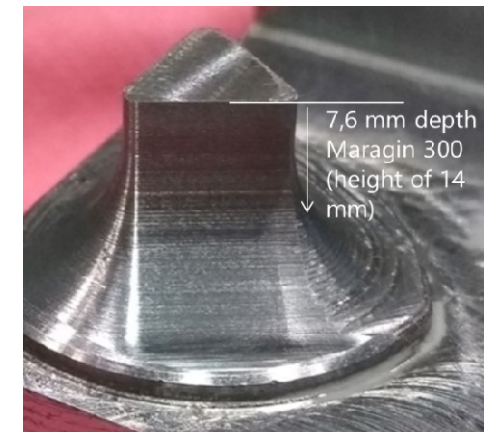
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Additive + Subtractive (Milling + Grinding)



(LxWxD)=20.8 x 20.7 x 7.9 mm



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Thank You Very Much!

Merci Beaucoup!

Bedankt!