

Plasma Electrolytic Polishing of LPBF Ti-6Al-4V: Surface Integrity, Tensile Fatigue Behavior of Solid Specimens, and FEA-Guided Stress Analysis of Gyroid Scaffolds

Syed Mesum Raza Naqvi ^{1,2,†}, Xinyuan Tian ^{1,2,†}, Chen Jiao ^{3,*}, Jiasen Gu ^{1,2,4},
 Syed Zohair Raza Naqvi ⁵, Kai Zhou ^{1,2,4}, Siyuan Fan ^{1,2}, Hongwei Chen ^{1,2}, Muhammad Ali Nasir ⁶,
 Owaisur Rahman Shah ⁷, Zongjun Tian ^{1,2,4} and Lida Shen ^{1,2,4,*}

¹ College of Mechanical and Electrical Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China; r.naqvi@nuaa.edu.cn (S.M.R.N.)

² Institute of Additive Manufacturing (3D Printing), Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China

³ Department of Mechanical and Aerospace Engineering, Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong SAR 999077, China

⁴ Wuxi Institute, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, China

⁵ College of Automation Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing 211106, China

⁶ Department of Mechanical Engineering, University of Engineering and Technology, Taxila 47070, Pakistan

⁷ Mechanical Engineering Department, Institute of Space Technology, Islamabad 44000, Pakistan

* Correspondence: mechenj@ust.hk (C.J.); ldshen@nuaa.edu.cn (L.S.)

† These authors contributed equally to this work.

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Supplementary Information

1. The scanning electron microscope (SEM) morphology of Ti-6Al-4V powder is shown in Fig. S1.

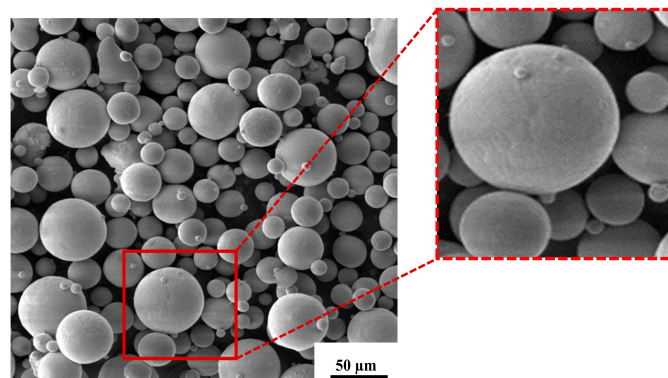


Figure S1. Scanning electron microscope (SEM) morphology of Ti-6Al-4V powder.

Table S1. Configuration details for the computing environment	
Name	Configuration
Operating system	Windows 11 (64-bit)
Algorithm model	John-Cook Damage Model

Computational time	3600-8700 s
Software	Abaqus/Explicit 2020
Meomory	32 GB
Processor	Intel(R) Core(M) i5-14600K (3.50 GHz)

Table S2: Chemical composition of Ti-6Al-4V powder.

Element	Al	V	Fe	Y	C	O	N	H	Ti	Others
Mass Fraction (%)	6.13	3.95	0.12	<0.005	0.006	0.065	0.012	0.005	Bal.	<0.12

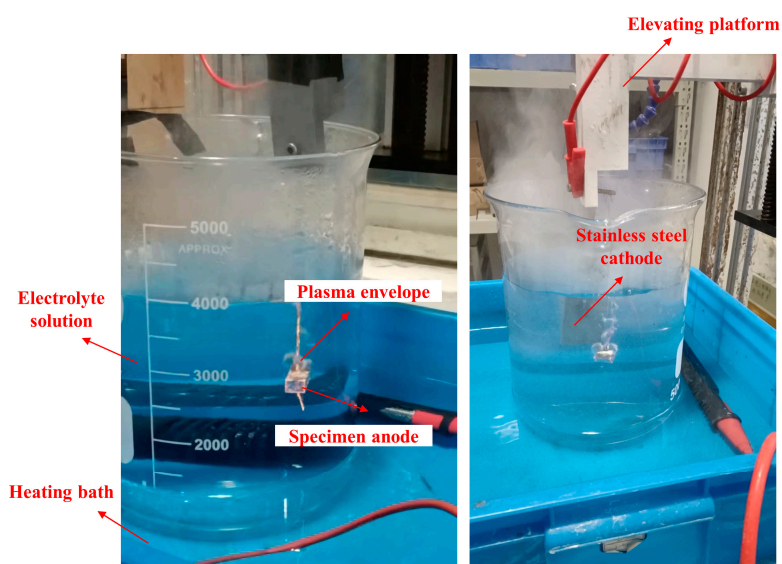


Figure S2. Plasma electrolytic polishing PEP experimental setup.



Figure S3. Surface roughness measurement of the LPBF-fabricated Ti-6Al-4V solid tensile specimens, Mitutoyo Surftest SJ-210 portable surface roughness tester.

Table S3. Surface roughness R_a (μm) of as-built, PEP-treated specimens, standard deviations, and percentage improvement (%) relative to the as-built condition under different PEP durations.

Sr. No	Sample 1	Sample 2	Sample 3	Average $R_a \pm \text{SD}$	Percentage Improvement
	R_a (μm)	R_a (μm)	R_a (μm)	(μm)	(%)
As-built (LPBF)	19.25	17.55	16.75	17.85 ± 1.27	-
PEP 15 min	5.08	4.50	7.46	5.68 ± 1.57	68.18%
PEP 20 min	2.42	3.32	2.77	2.84 ± 0.45	84.10%
PEP 25 min	4.48	3.51	2.59	3.53 ± 0.95	80.22%

Table S4. Tensile fatigue cycles to failure (N_f) of as-built, PEP-treated specimens, standard deviations, and percentage improvement (%) relative to the as-built condition under different PEP durations.

Sr. No	Sample 1	Sample 2	Sample 3	Average Fatigue $\bar{N}_f \pm \text{SD}$ (Cycles)	Percentage Improvement
	(N_f)	(N_f)	(N_f)		(%)
As-built (LPBF)	2419	2472	2248	2380 ± 117	-
PEP 15 min	2551	3178	2274	2668 ± 463	12.10%
PEP 20 min	3528	2308	3478	3105 ± 690	30.46%
PEP 25 min	3443	2533	1579	2518 ± 932	5.79%