Improving Component Life and Performance

LPB vs Laser Peening: R0

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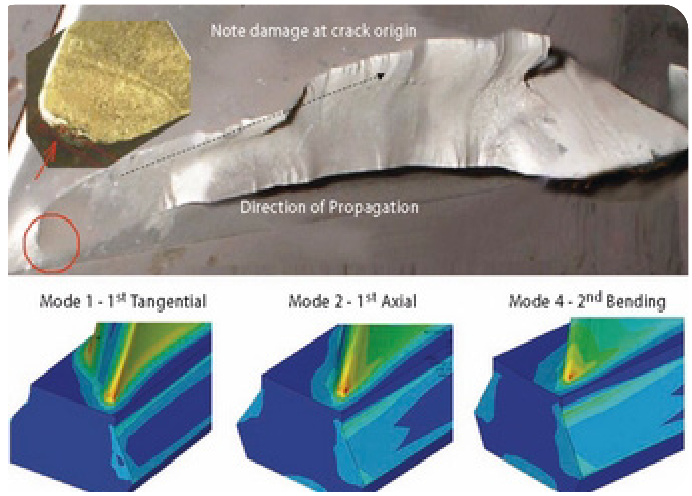
EPRI (Electric Power Research Institute) reports that the primary life-limiting factor for 7FA gas turbines is high cycle fatigue cracking propagating from erosion damage at the leading edge of the R0 compressor blade. Blending of the blade edge is required once erosion damage reaches 0.008in. (0.2mm). This occurs approximately every 500 starts and necessitates blade replacement, requiring extended equipment downtime.[1]

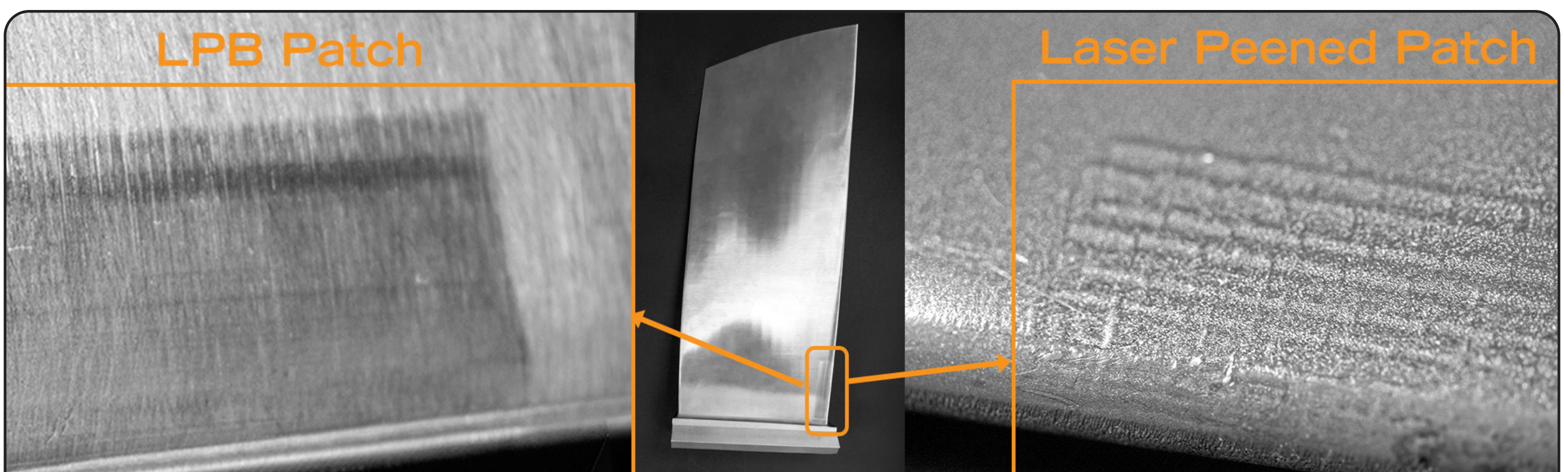


Cracked Leading Edge of R0 Blade[1]

Efforts to decrease the frequency of blending and blade replacement have included 1) thickening the leading edge of the blade 2) changing the material of the blade and 3) laser shock peening to apply residual compressive stress to the leading edge. All of these solutions provide some improvement, but have limitations. Material changes and thickening of the blade only provided a moderate improvement in fatigue life while degrading engine performance. Laser peening can effectively impart compressive stress to the blade, but is damaging to the surface, producing nearly four times the roughness of LPB at the the critical boundary layer. It is only applied to new blades and doesn't allow for further repair once the blending threshold is met.

SOLUTION: Lambda Technologies developed a solution to extend the fatigue life and improve the damage tolerance of the R0 blades. Using low plasticity burnishing (LPB®), Lambda Technologies' engineers applied a deep, stable layer of engineered compression to the leading edge region of the blades. The goal of this project was to match or exceed the compression of laser peened blades and improve damage tolerance.

R0 blades were processed with LPB and laser peening, respectively. Erosion damage was simulated at 0.025in. (0.63mm) to imitate damage well over the threshold allowed in service.



LPB Finish: 7.0 μ-inch Ra **LSP Finish: 26.4 μ-inch Ra**

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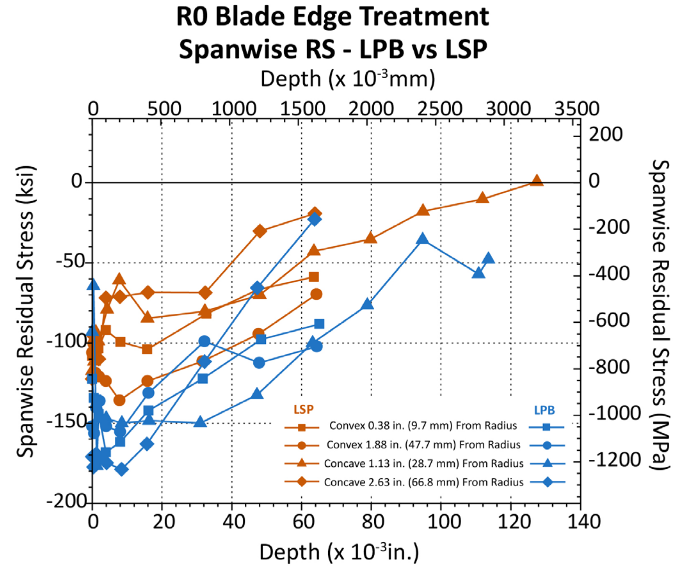
Fatigue testing and residual stress measurements were made to compare the surface enhancement processes. All measurements and testing were performed by Lambda Research, Inc.

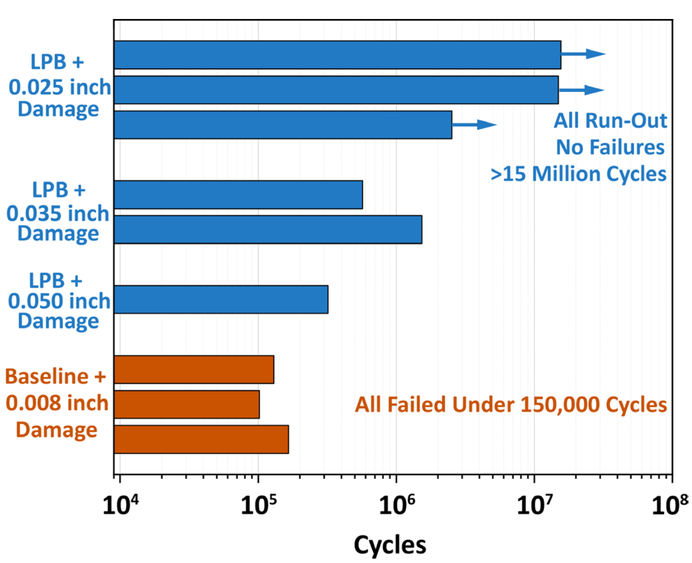
IMPACT: With LPB, through-thickness compression was achieved on the leading edge of the R0 blade, effectively providing infinite life for blades with damage <0.025in. (0.63mm), including those that reach the current blending threshold. Damage tolerance was improved by a factor of three compared to the baseline blades.

LPB produced residual compression that was nominally 50% higher in magnitude at all depths and locations measured compared to laser peening.

“Low plasticity…burnished blade’s residual stress measurements met or exceeded the compressive layer depth and magnitude of the originally applied laser shock peened compressive patch.”[2]



Imparted Compression on LE of R0 Blade



HCF Results & Damage Tolerance Analysis

Selecting low plasticity burnishing over laser peening for R0 blades provides a 50% improvement in magnitude of compression with less damage to the surface. The process can be applied to new and used blades. LPB extends component life while increasing reliability, confidence, and margins of safety.

1 EPRI (2019). Cracking the FA R0 problem. *Modern Power Systems*. https://www.modernpowersystems.com/features/featurecracking-the-fa-r0-problem//featurecracking-the-fa-r0-problem-412766.html

2 EPRI (2015). Improving compressor airfoil damage tolerance: evaluation of compressive layer surface treatment. *Gas Turbine Advanced Components and Technologies* https://www.epri.com/research/products/3002006059

Call or email us to learn how burnishing will improve the surface integrity of your component.

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