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Mitigation of Foreign Object Damage (FOD)

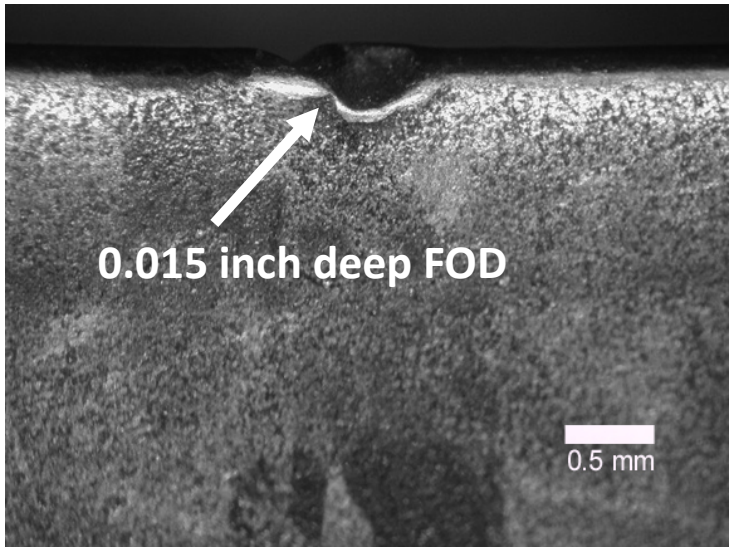
Preventing Crack Growth in Turbine Engine Blades

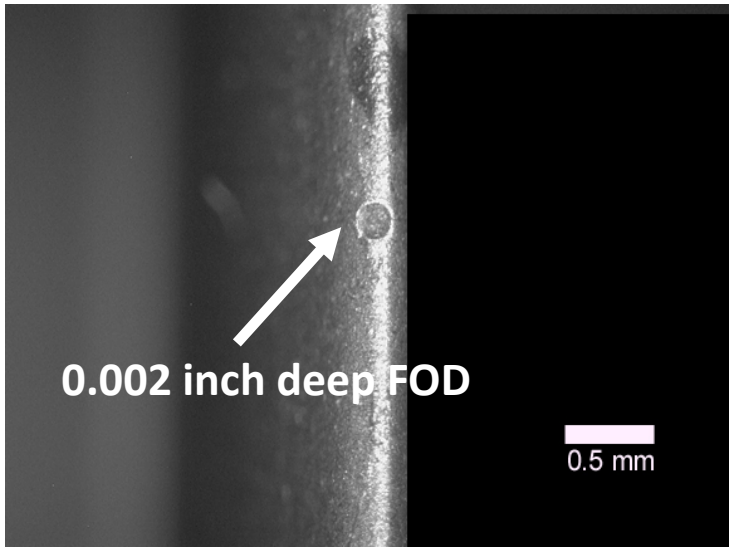
Supported by:

LAMBDA Technologies Group

Detrimental Effects of Foreign Object Damage

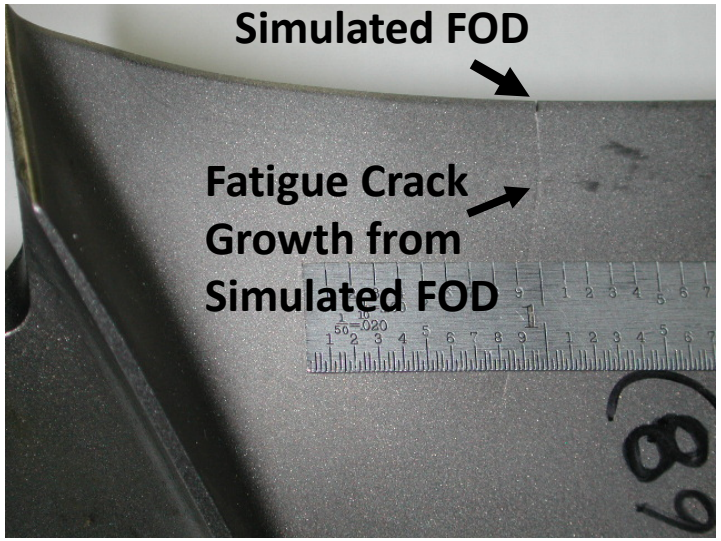
- Caused by any foreign object coming into contact with the engine (sand, dirt, ice, dropped tools, etc)
- Aircraft engines are prone to FOD
- Land-based engines are prone to ice/rust chips liberating during operation
- FOD at critical blade edge locations are prone to high vibratory stresses and fatigue cracking
- Fan and compressor blade edges are prone to FOD-initiated fatigue





Consequences

- Potential catastrophic failure
- Premature retirement of blades from service
- Frequent Inspection/blending
- Compromised engine efficiency



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Common Treatments

- Preventing FOD from occurring – removal of FOD-creating debris is slow and tedious
- Frequent inspections and blending FOD from blade edges – engine downtime, expensive inspections, reduced power output, and blade blending limits
- Developing materials with improved inherent damage tolerance – expensive and time consuming
- Use of hard coatings – local breakdown of coatings exacerbates the problem
- Frequent replacement of blades – increased total ownership costs

These treatments do not improve damage tolerance and should not be considered permanent solutions.

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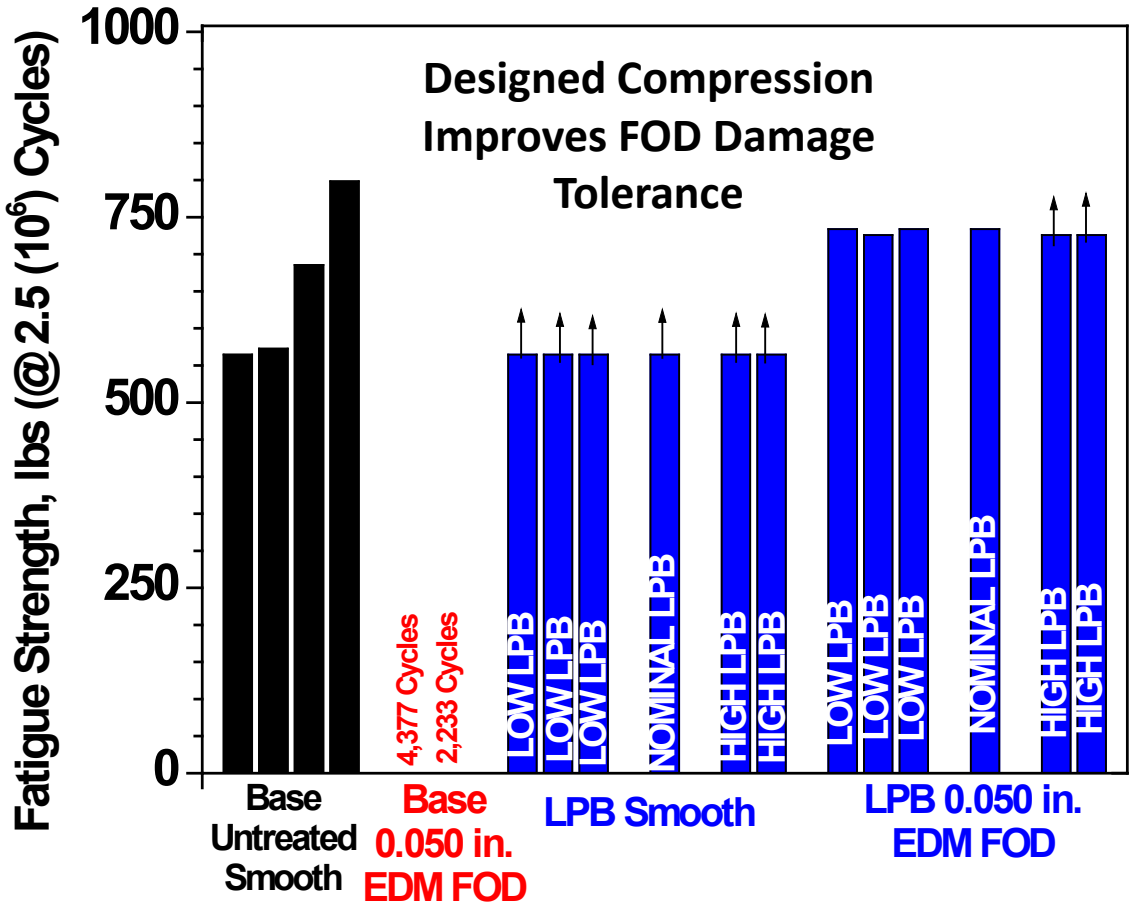
Designed Compression



Successful Applications

- F402 LPC1 Blade edges
- F402 LPC2-6 Blade edges
- F404 Fan blade edges

Benefits

- Extend Component Life
- No Material Replacement
- No Redesign
- Improve Damage Tolerance
- Reduce Risk of Failure
- Improve Cost Savings

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Improved Damage Tolerance
Cost-Effective Life Extension for Gas Turbine Engines