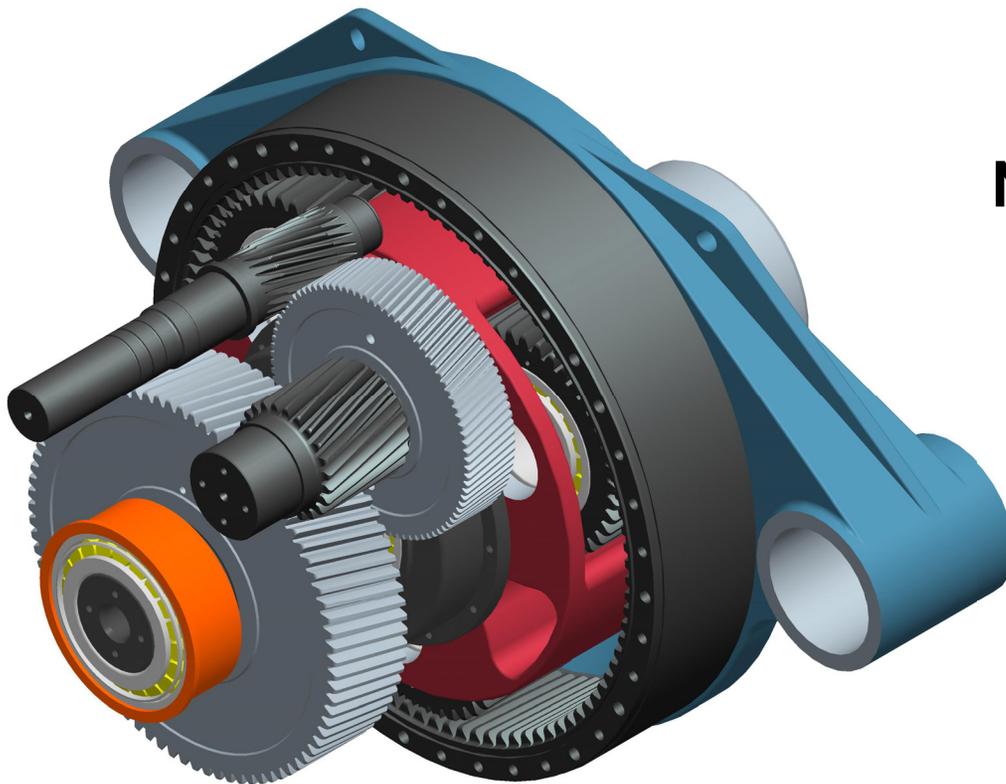


# Wind Turbine Micropitting Workshop



**Sandy Butterfield**  
**Chief Engineer**  
**National Wind Technology Center**

**NREL**

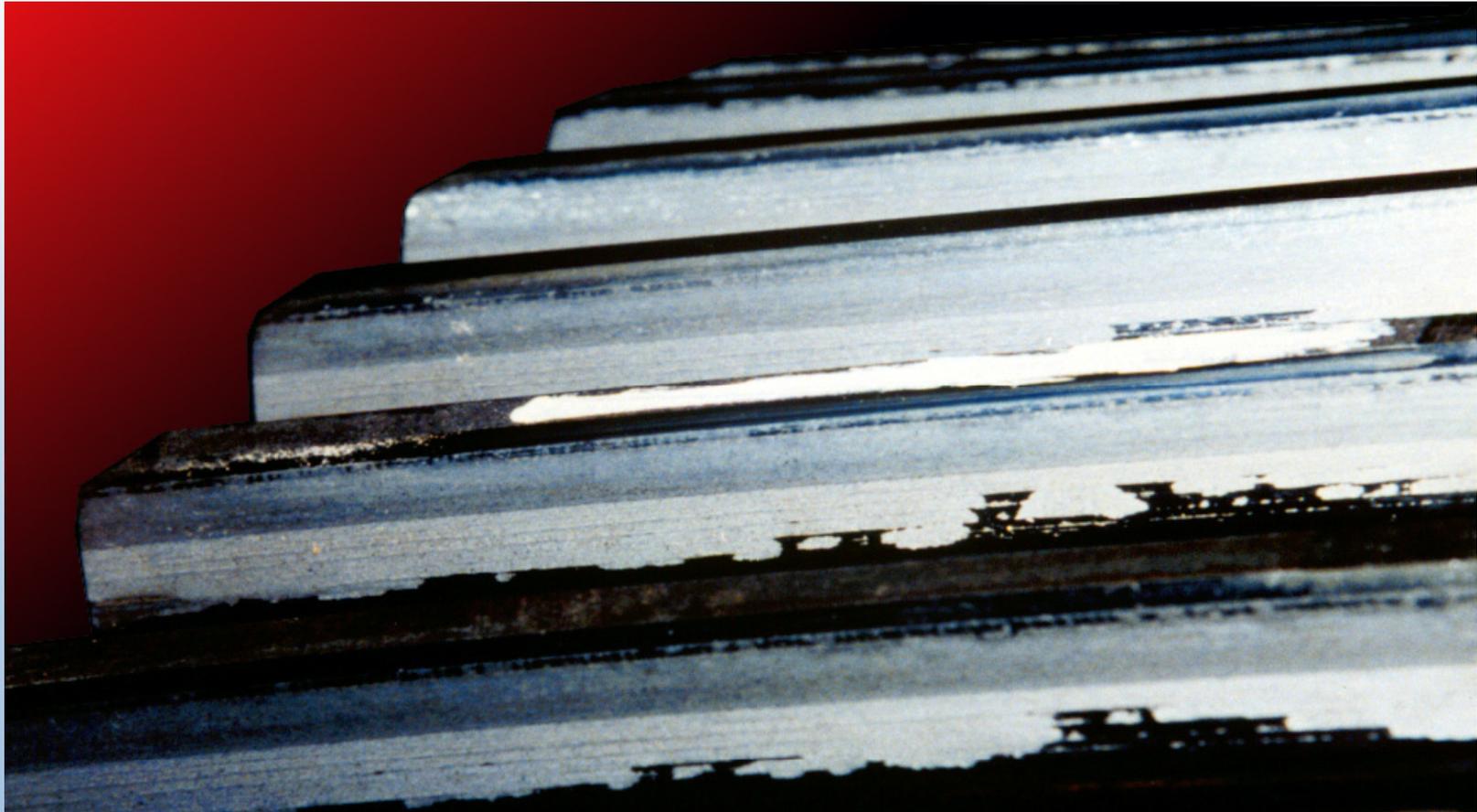
**June 18, 2009**

X.X+0.1  
X.XX+0.01  
X.XXX+0.001  
ANG.+0.5

# Outline

- What is micropitting?
- Why is it important for wind turbine gearboxes?
- NREL micropitting workshop summary
- Next steps

# What is Micropitting? – ground WT LSG



3

Ref: Errichello (1999)

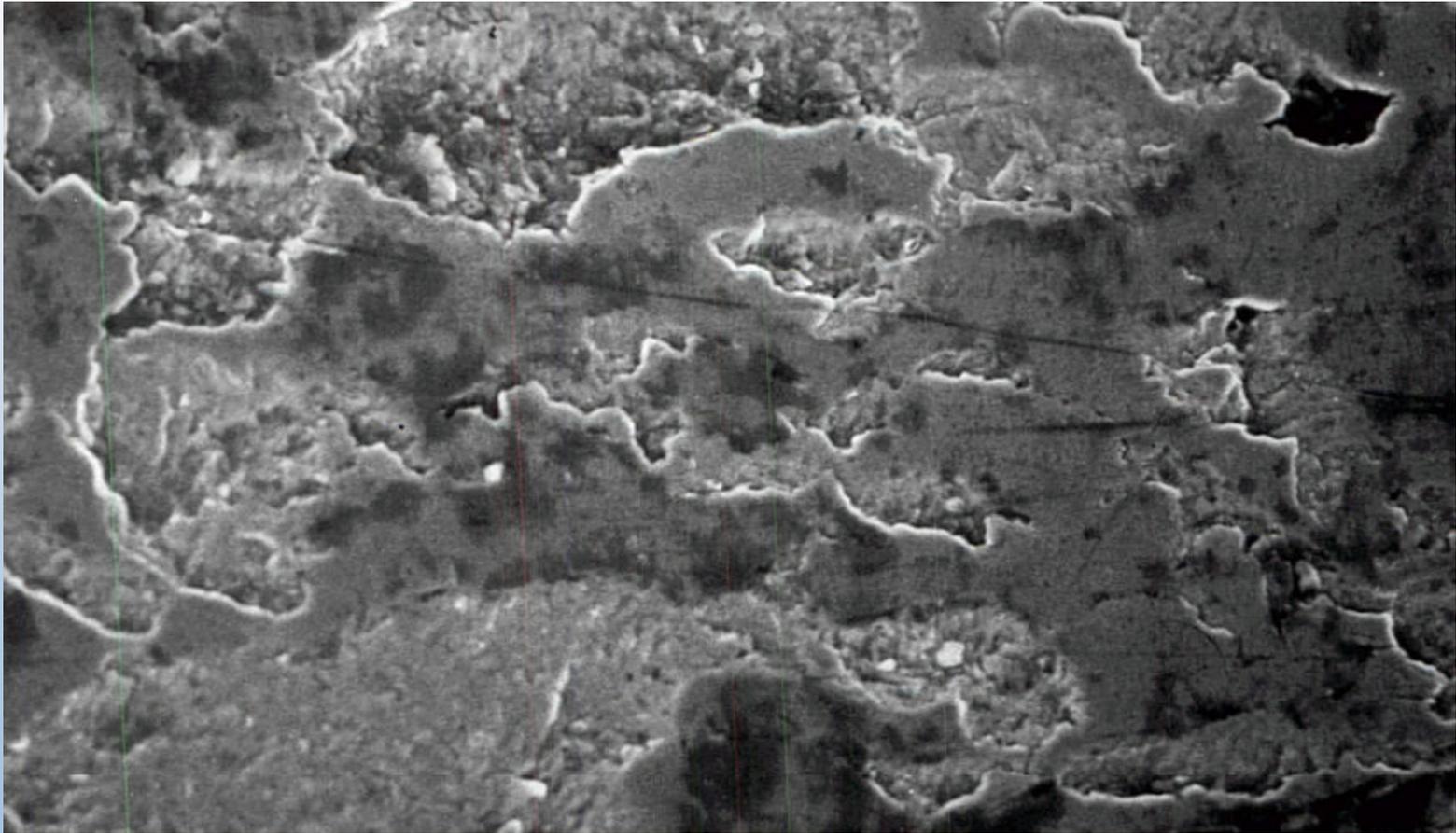
# Micropitting - ground WT sun



4

Ref: Errichello (1999)

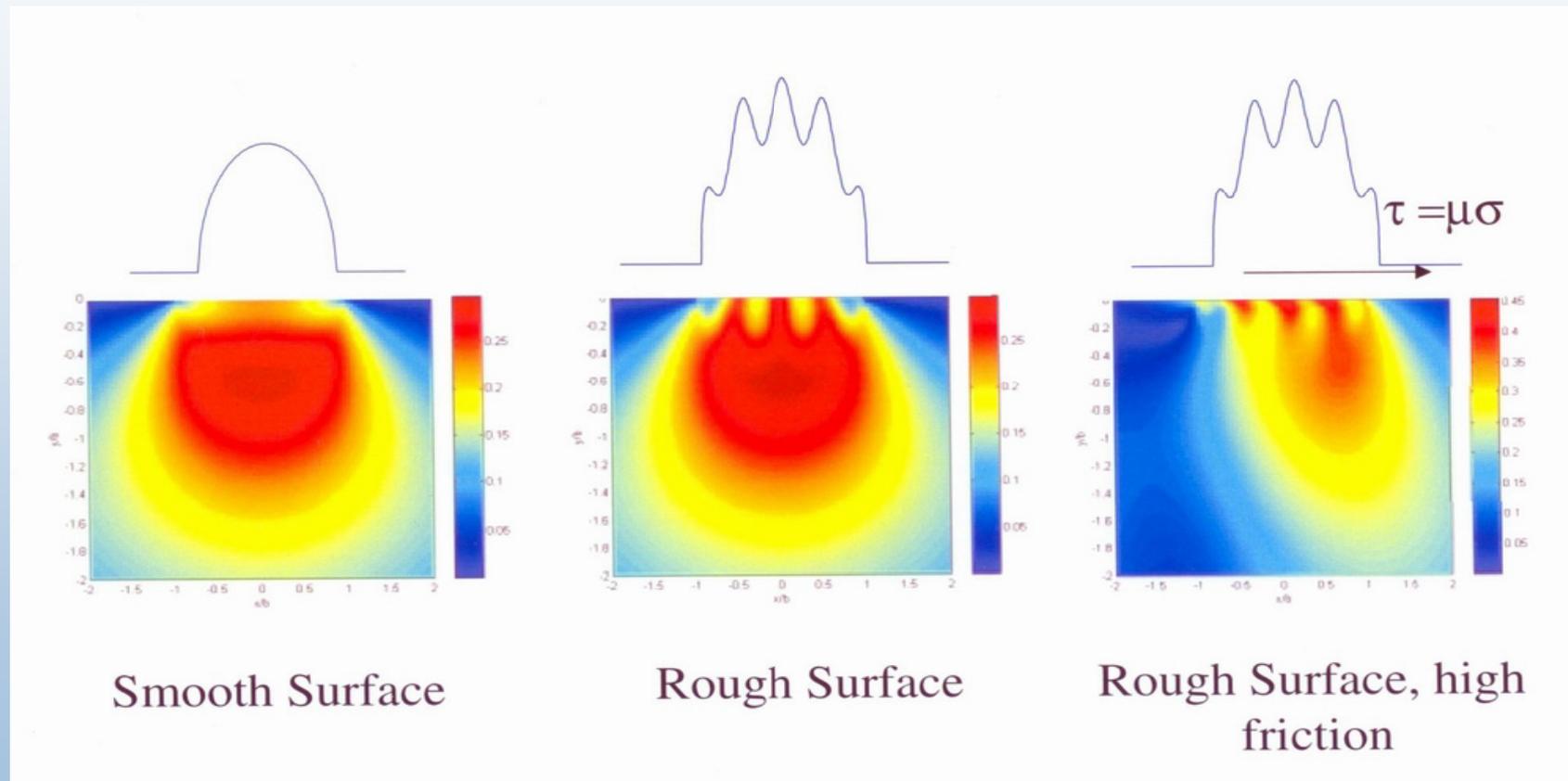
# SEM shows fatigue cracks



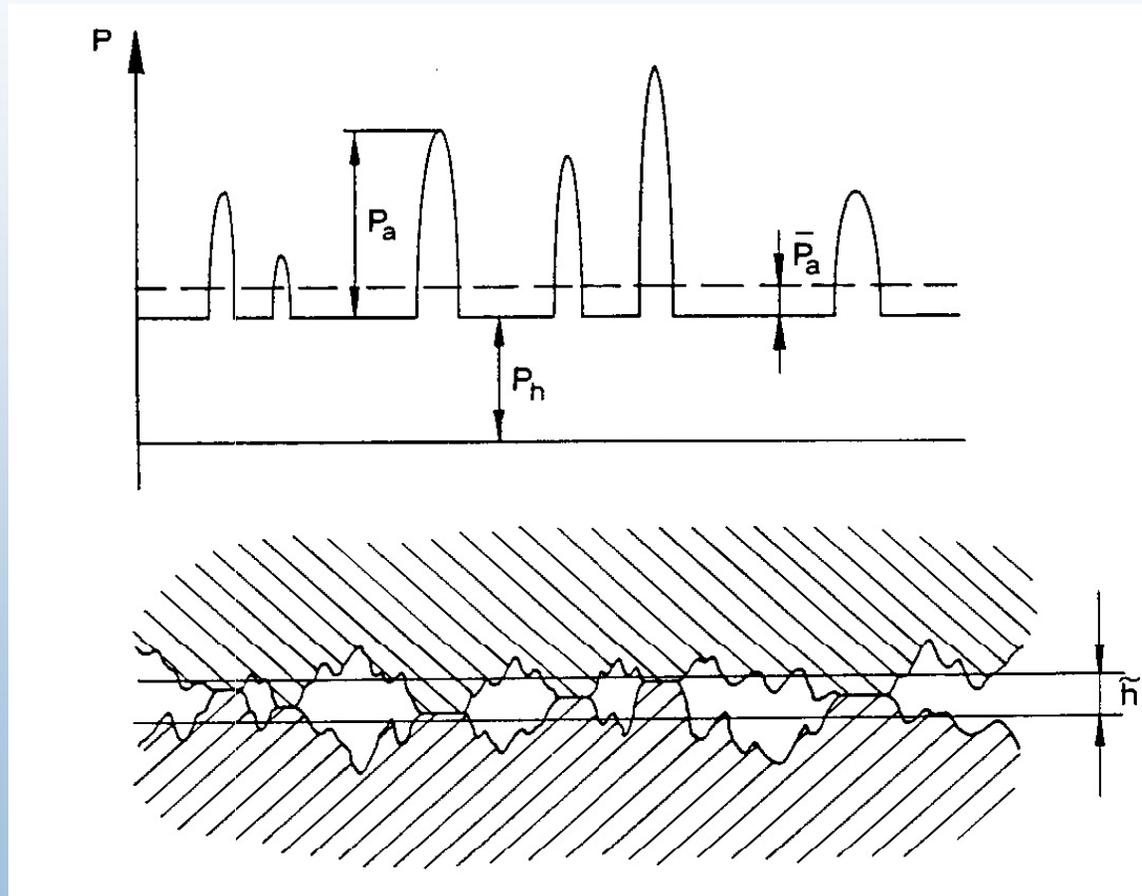
5

Ref: Errichello (1984)

# Roughness increases stress

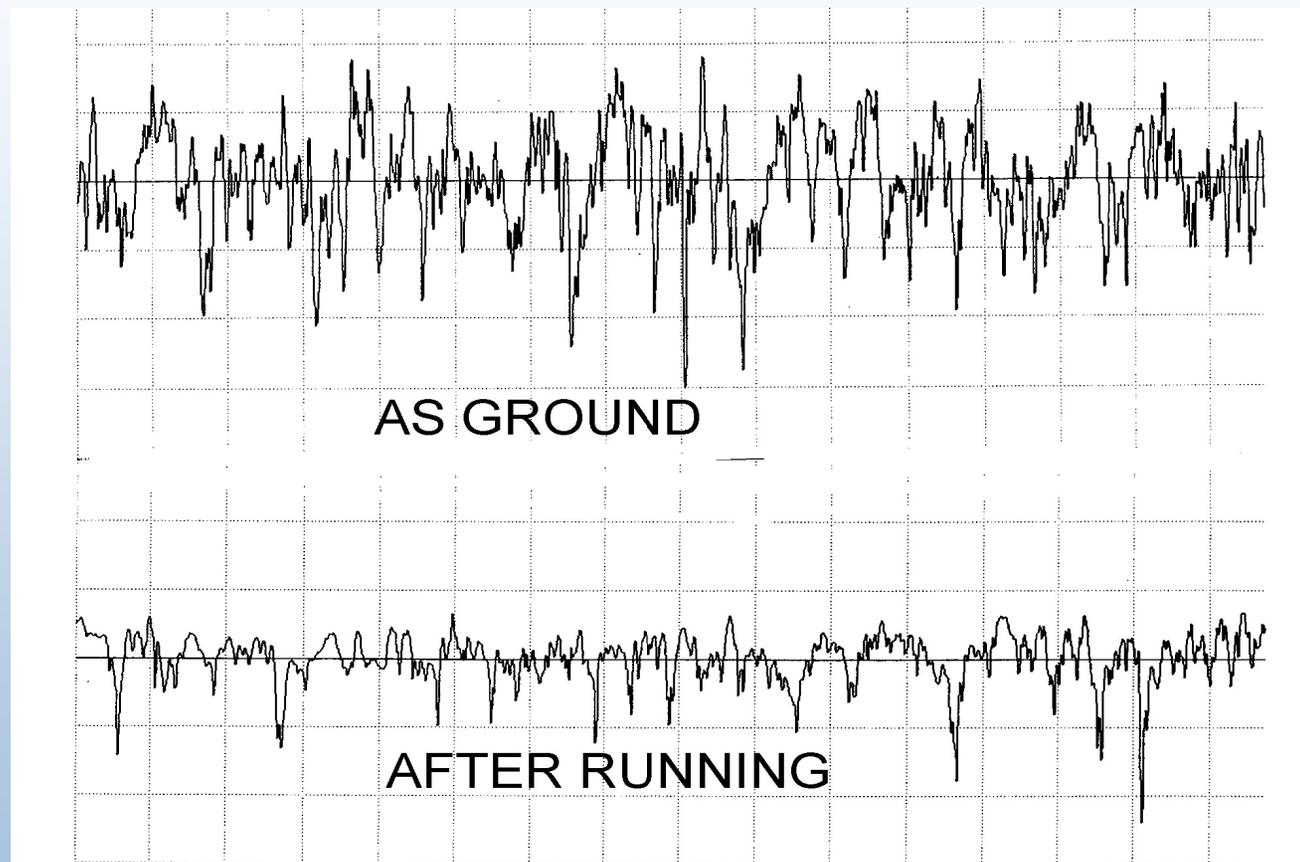


# Asperities & oil film share load

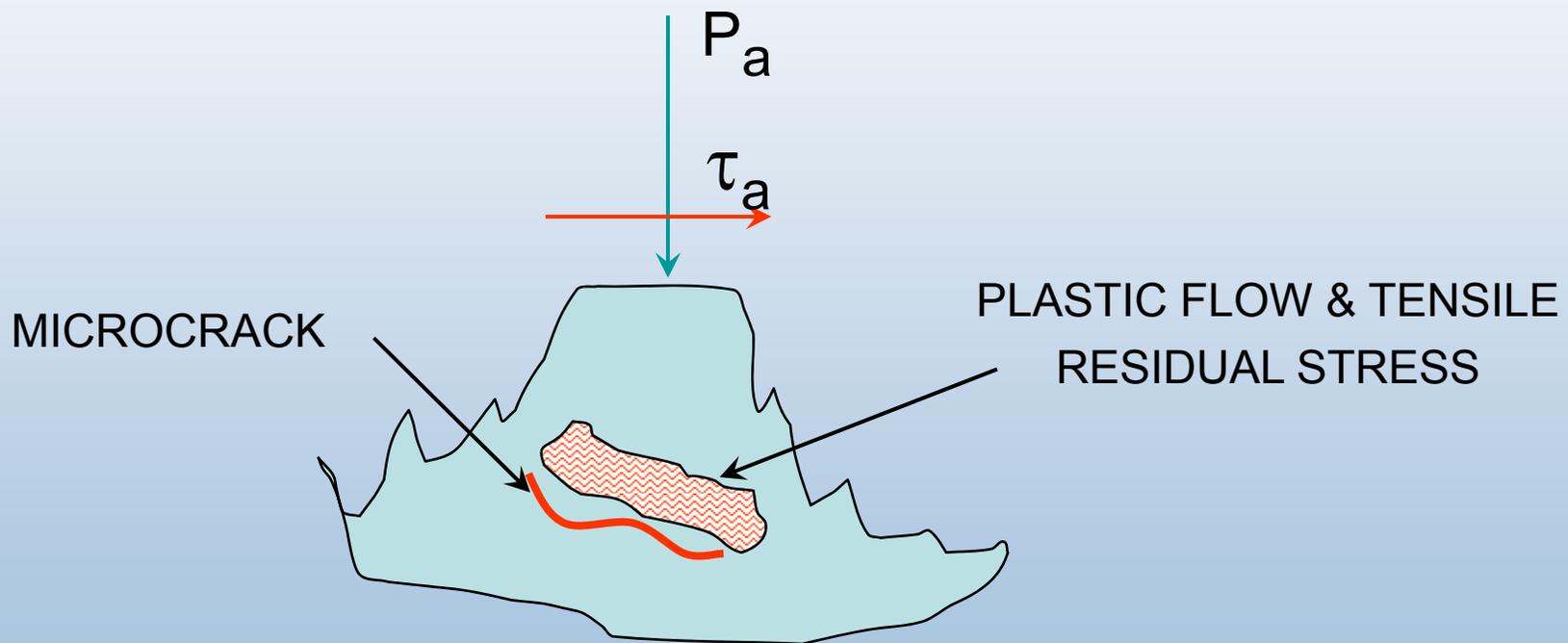


Ref: Johnson, Greenwood & Poon (1972)

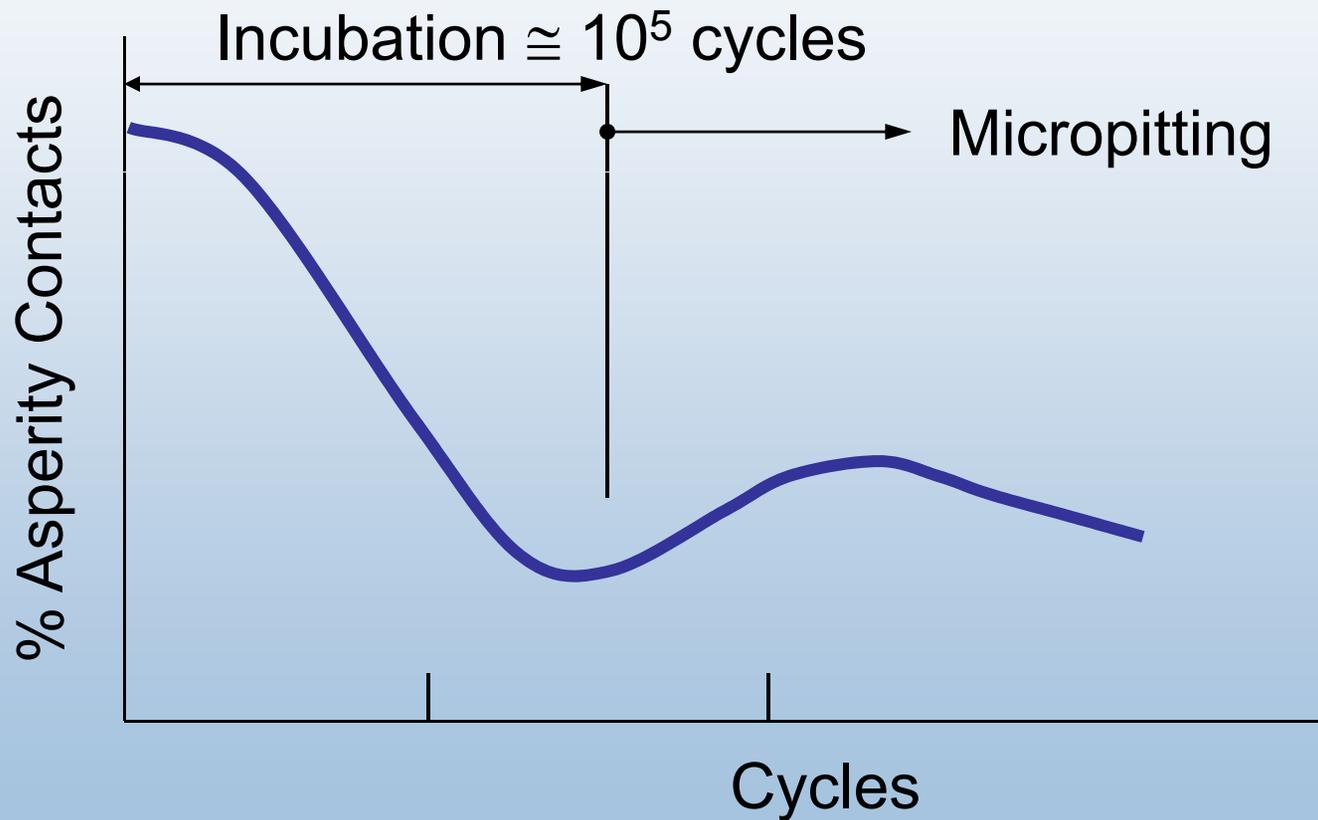
# Asperities deform during run-in



# Asperities deform & crack



# $\mu$ pit incubation occurs early



# $\mu$ pitting may escalate



11

Ref: Errichello (1995)

# Summary of $\mu$ pitting features

- Low  $\lambda$  promotes micropitting
- Asperities & oil film share load
- Asperities deform & crack during run-in
- $\mu$ pit incubation occurs early
- After incubation,  $\mu$ pits grow
- $\mu$ pitting degrades accuracy
- $\mu$ pitting may escalate

# NREL Micropitting Workshop

- Held at NREL, April 15-16, 2009
- International experts invited
- Consensus on state-of-the art
- Discuss impact on wind turbine gears/bearings
- Discuss methods for research and deeper understanding

# Conclusions

- Wind turbines present unique micropitting environment
  - Extreme contact pressure
  - Low pitch line velocities
- Testing to simulate conditions is needed
- Modeling could also help
- Surface finish can help (gears more than bearings)

# Next Steps

- Complete proceedings
- Plan another workshop 12 months
- Investigate research options

# NREL/DOE Gearbox Reliability Program

