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U-Net Based Quantification of Fretting Fatigue Damage and Crack Propagation in Shot-Peened Ti-6Al-4V Dovetail Joints

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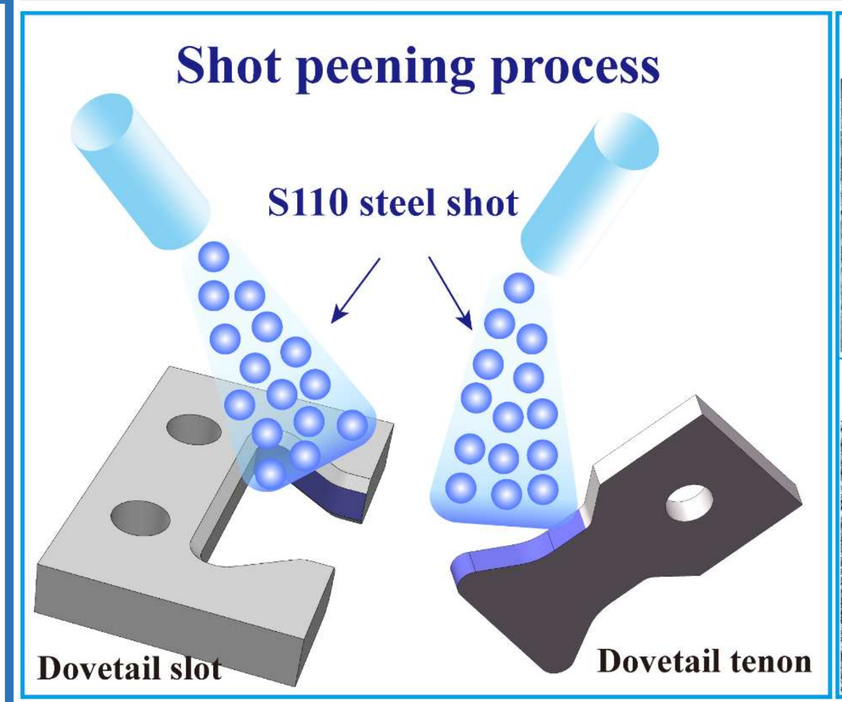
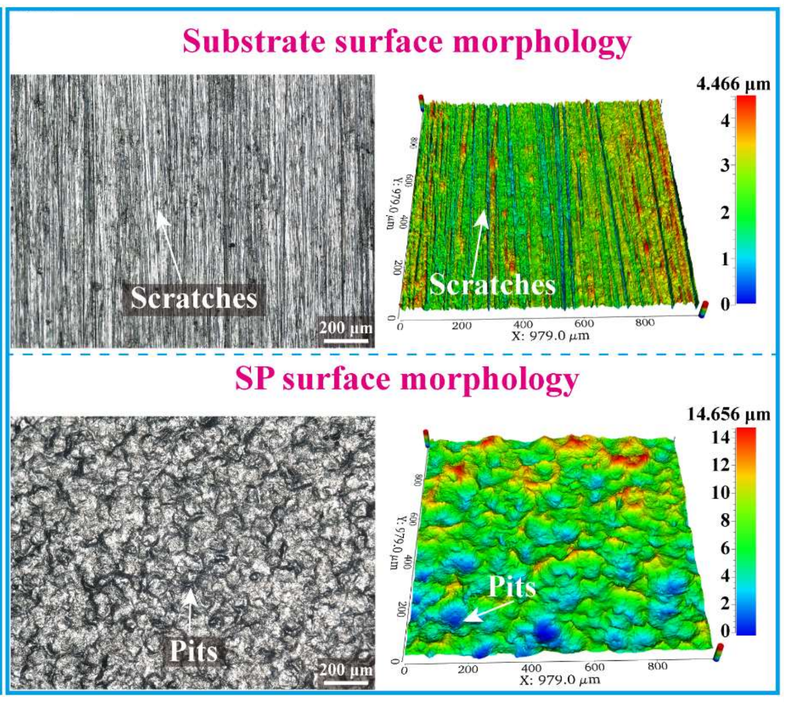
1. Background

- Fretting fatigue at dovetail joints is acritical failure mode in aero-engineblade-disc connections.
- Shot peening (SP) is widely used toimprove fatigue resistance, but its rolein crack initiation and propagation isload dependent.
- A four-camera in situ observationsystem and U-Net model were usedto monitor crack evolution andquantify crack length.
- Objective: clarify how SP influencesfretting fatigue life, crack initiation,crack propagation, and damagemechanisms under different loads.

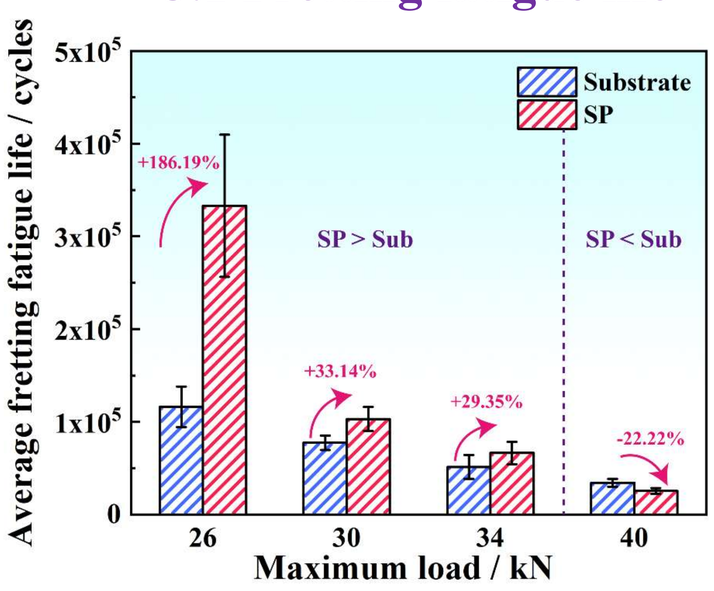
2. Experimental materials and methods



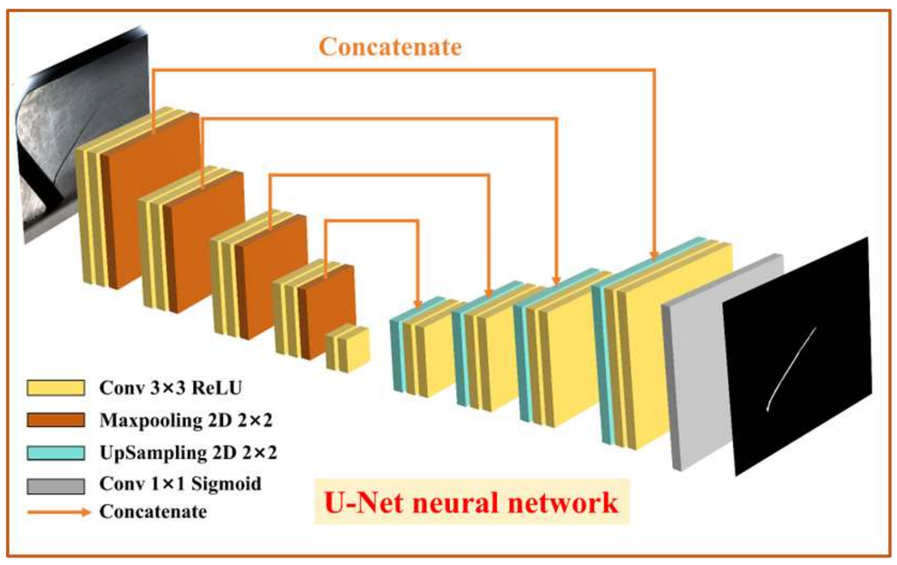


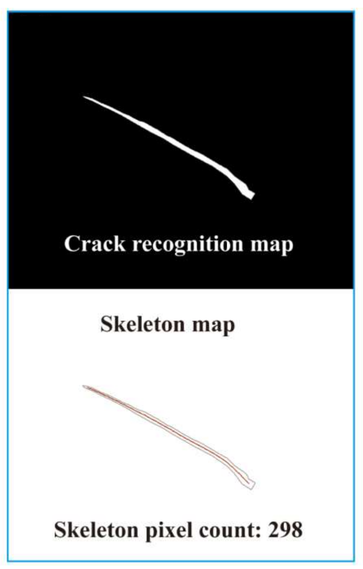
3. Key results

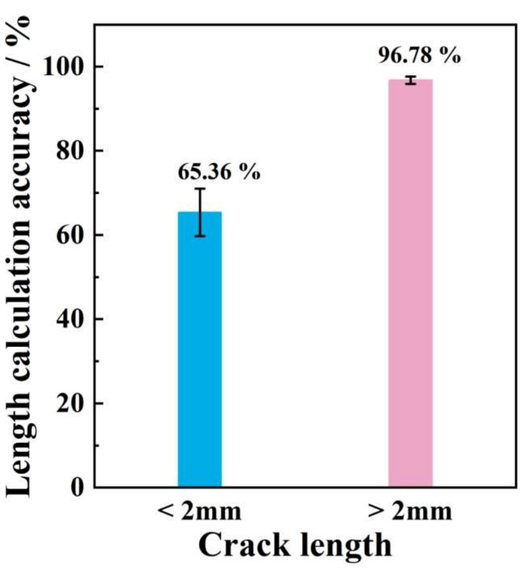
3.1 Fretting fatigue life



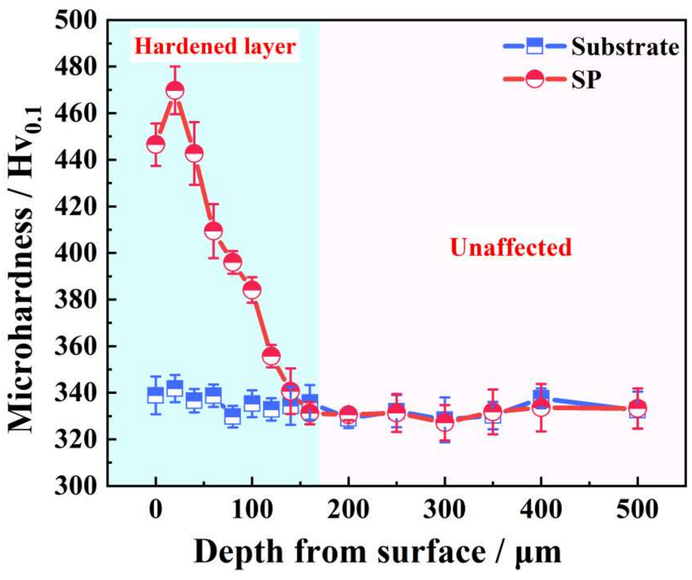
3.2 U-Net assisted crack analysis

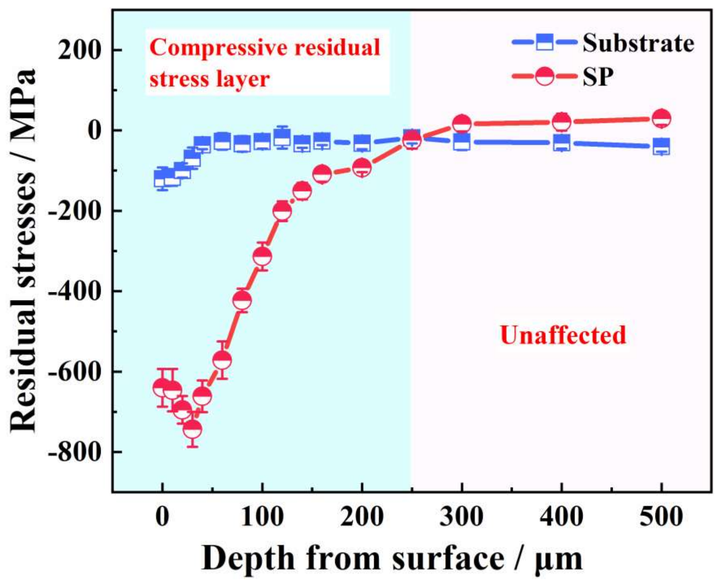






3.3 Hardness and residual stress





4. Main conclusions

1. At low and medium loads (26 34 kN), SP significantly enhances fretting fatigue life,with the largest incrcase of 186.1996 at 26 kN.
2. SP inereases the percentnge ofcrack initiation life under all loading conditions.
3. The beneficial cfeet of SP is mainly associated with surface hardening and compressiveresidual stress, which delay crack initiation and early crack growth.
4. At 40 kN, the beneficial eneet disappears and the overall lifc decreases because residualstress relaxes rapidly and roughness-induced stress concentration accelerates crackpropagation.T
5. he U Net model provides eficient crack identification and accurate crack lengthquantification,cspecially for cracks > 2 mm.