

Laser Glazing of Railroad Rail Materials

Procedure R & D

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Outline

- R & D work on further improving ANL's laser glazing technique
 - Goals ----faster & better surface finish
- Preliminary feasibility study on using laser to heal the service-cracked rails

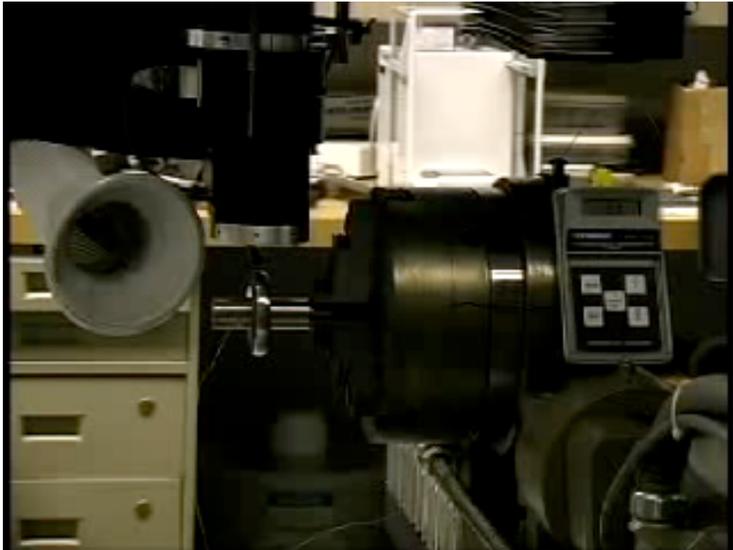
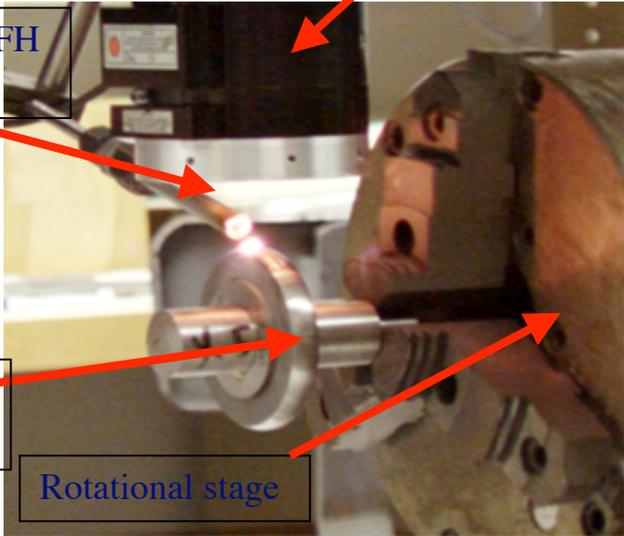
Experimental Setup

1.6 kW Pulsed Nd:YAG laser with fiber-optic beam delivery & optics

Nitrogen @ 50 CFH as shielding gas

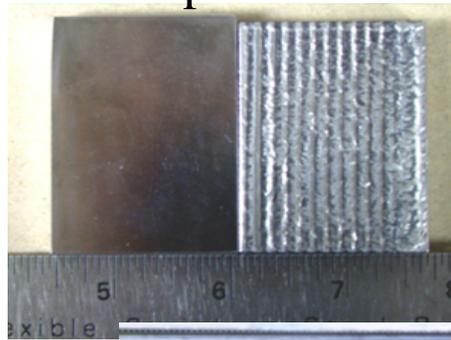
A wheel being laser-glazed

Rotational stage

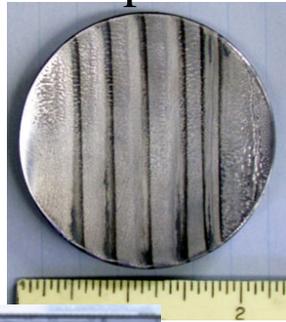


Recent Procedure R&D Focusing on Increasing Processing Speed and Smoothing Surface

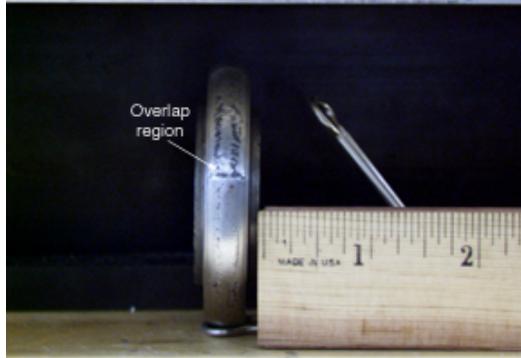
Old procedure



New procedure



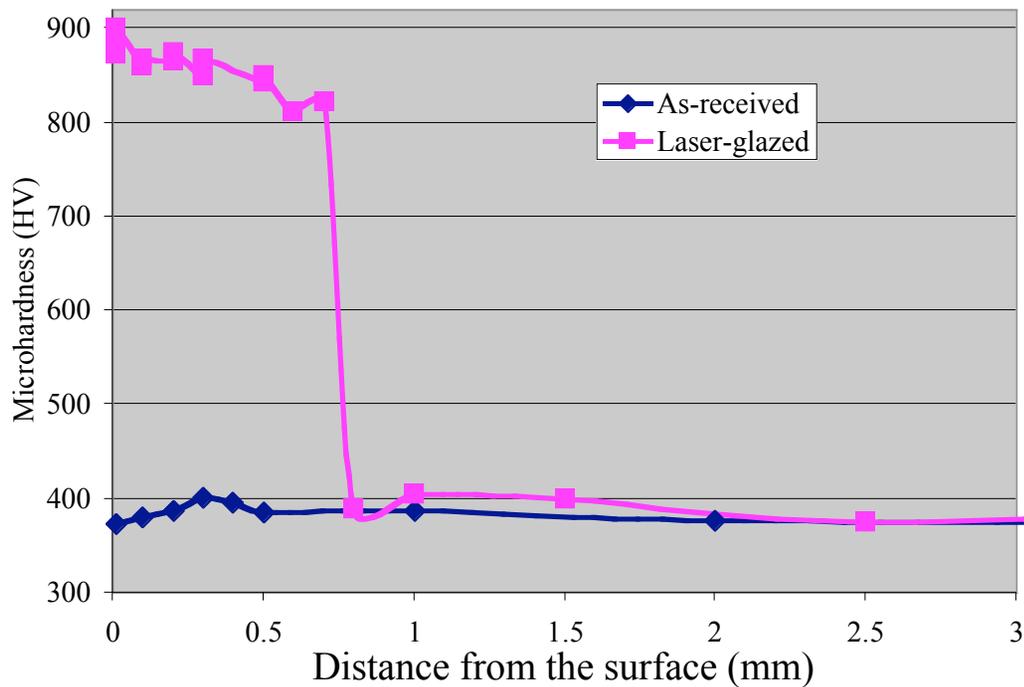
Faster processing speed by wider individual track, smaller track overlapping rate, and faster feeding.



Smother surface by avoiding deep surface melting by lower laser power density and faster feeding.

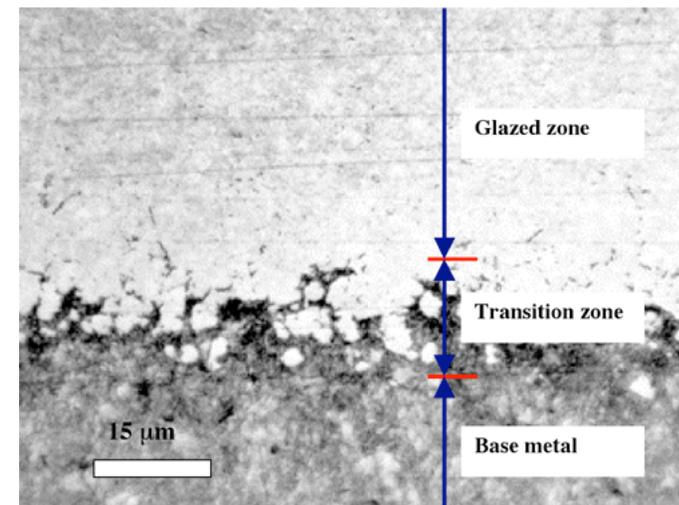
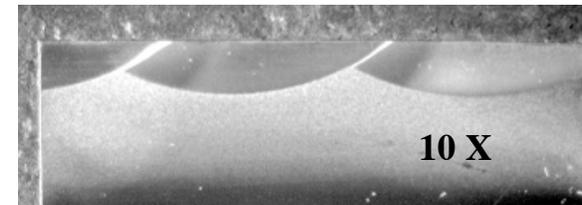


Microhardness and micrographs of Laser-glazed Rail Material



HV 800~ 900 and case depth 0.8 mm

Non affected substrate: HV 370 ~ 400



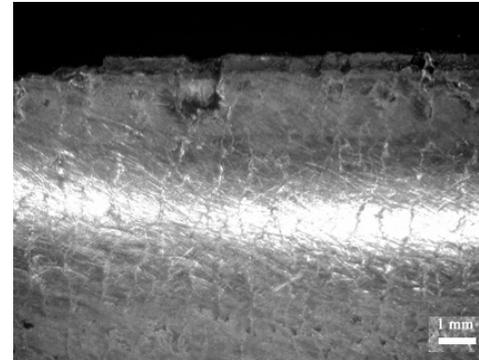
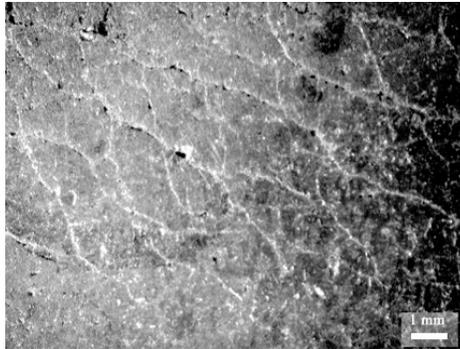
ANL Laser Lab



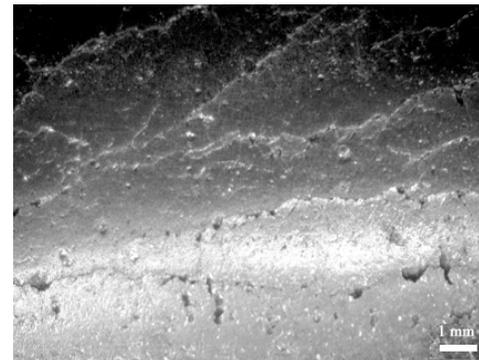
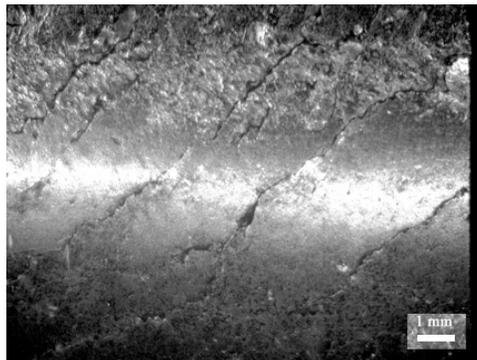
**Technology
Development**

Surface Crack Images of a Service-Cracked Rail

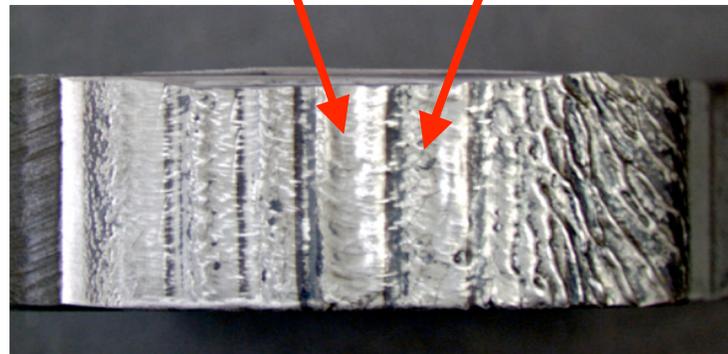
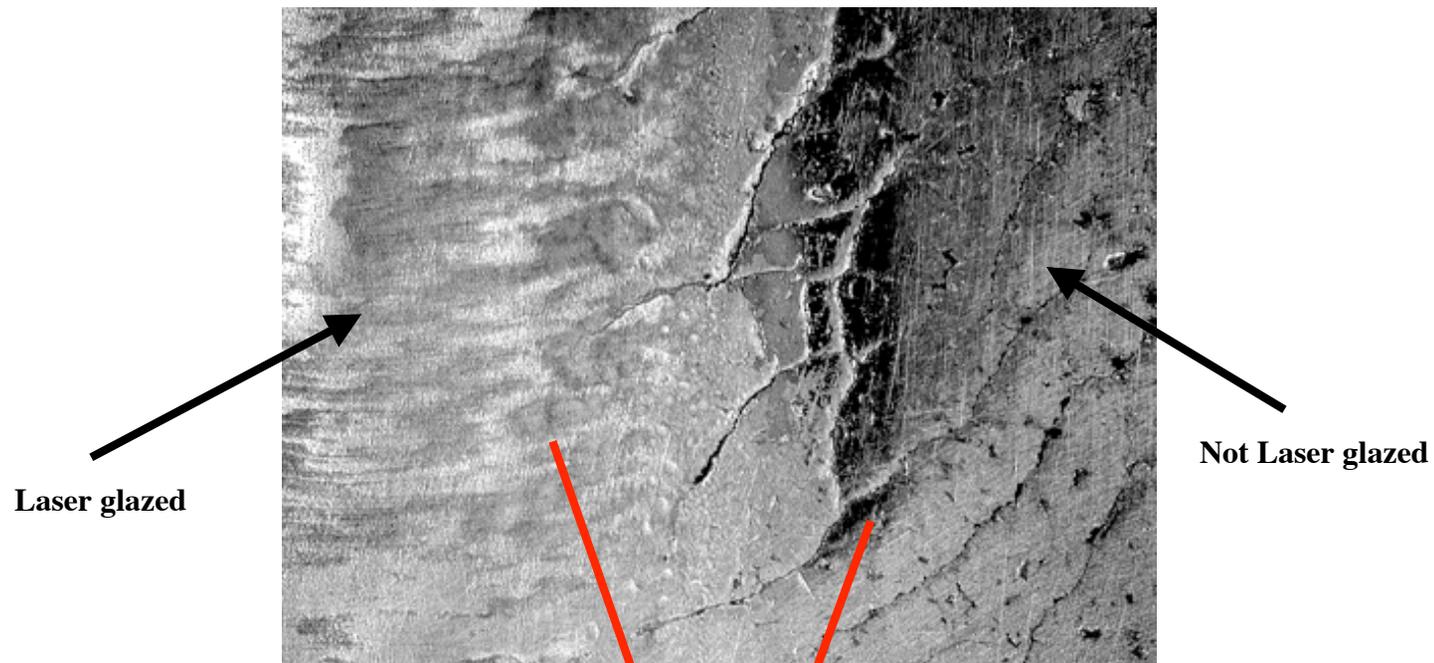
Shallow surface cracks



Deep surface cracks and pits



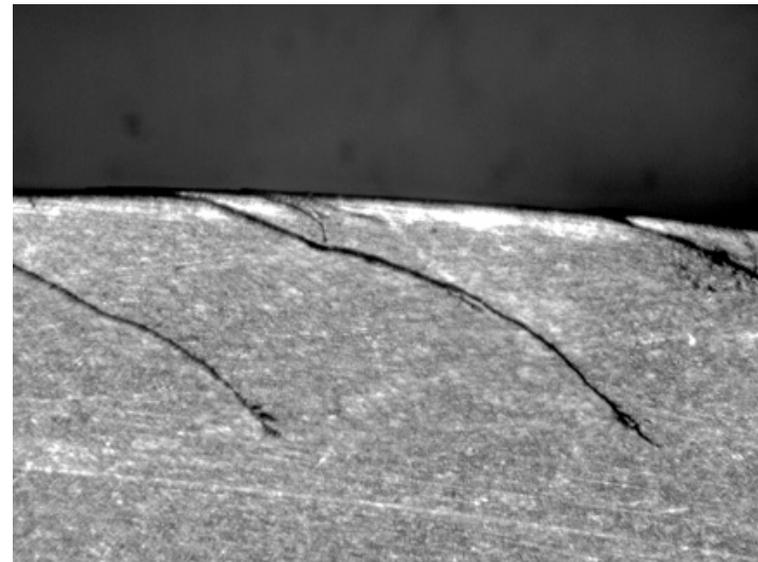
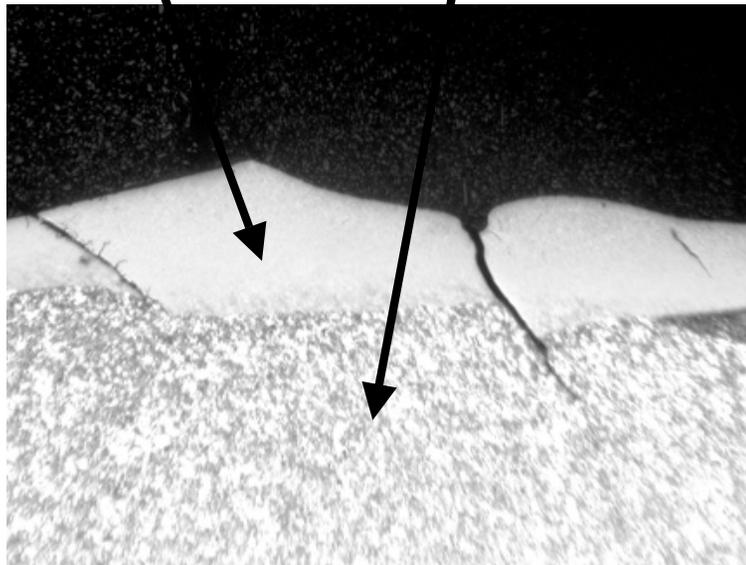
Comparison of Laser Glazed and Non-Glazed Surfaces



Cross-Section Images of Laser Glazed & As-Received Rail (Deep-Cracked Region)

Glazed surface layer

Not Glazed base



Glazed

1 mm

Not Glazed

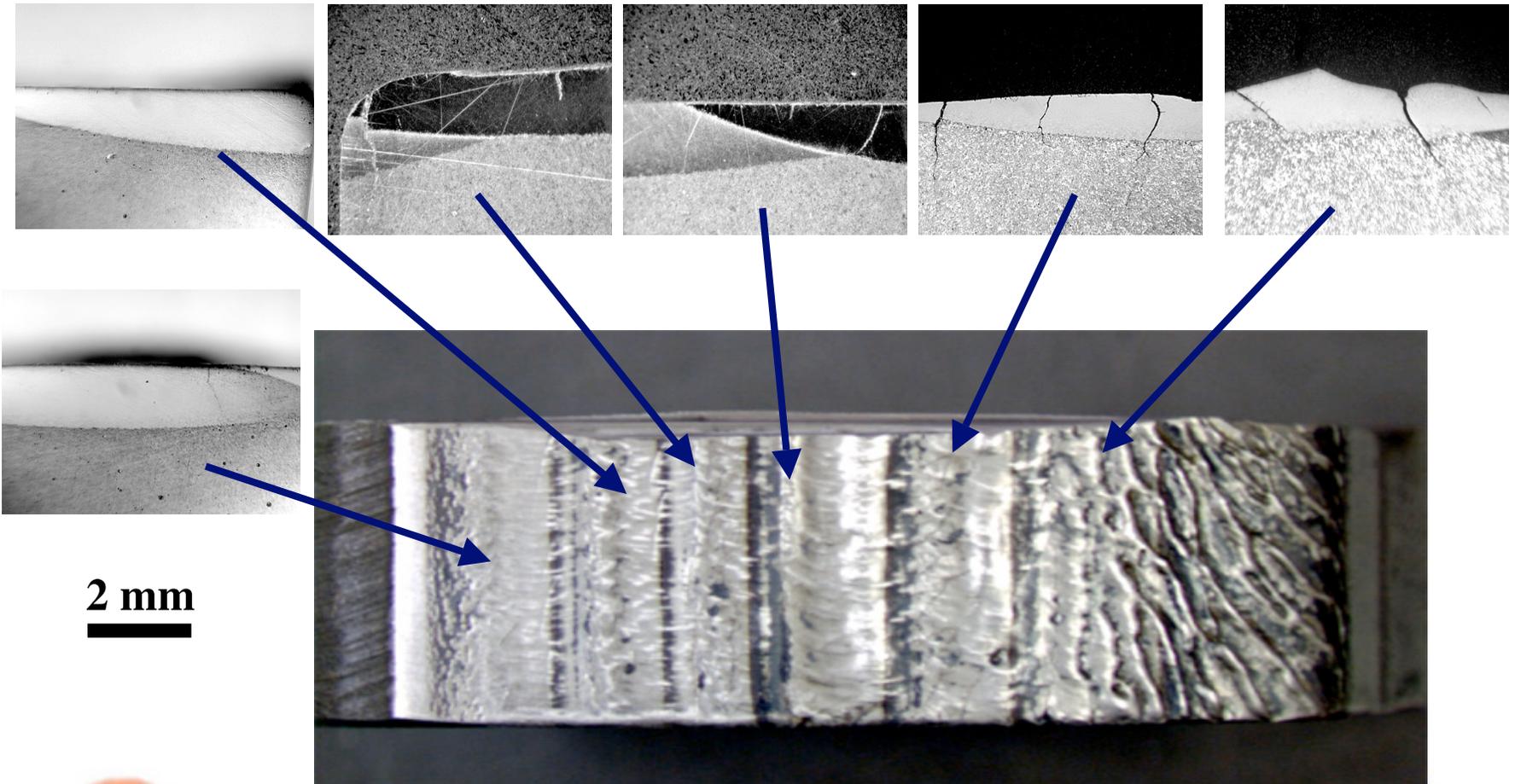


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Cross-Section Images of Laser Glazed Rail



2 mm



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Summary

- ANL's laser glazing technique can:
 - surface-strengthen railroad rails faster, and
 - produce surface finish adaptable for either :
 - lab wear testing samples or
 - direct rail applications
- Laser glazing produced a surface layer with following properties:
 - microhardness $HV > 800$ ($Hv_{\max} = 900.$)
 - case depth of 0.8 mm.
- By employing a multi-kilowatt laser, a much deeper glazed layer (potential up to 2 ~ 4 mm deep) can be achieved.
- Tribology study shows the glazed rail material has:
 - low friction coefficient
 - high wear resistance and
 - good durability.



Summary (cont.)

- Laser glazing has the potential to heal shallow surface cracks or micro pits on service-cracked rails.
- A systematic study must be done to establish the correlation between healable crack size and process parameters.

Future Work

- Further improvement of:
 - Processing speed,
 - Surface finish, and
 - Producing a deeper glazed layer
- Laser glazing of real rails
- Conceptual design of a prototype laser glazing system

