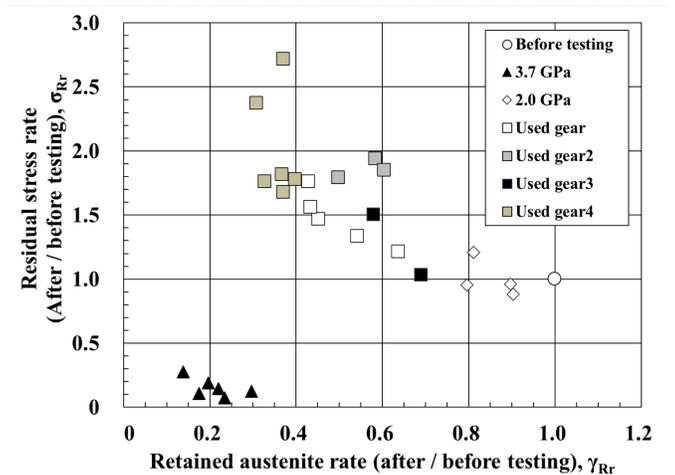
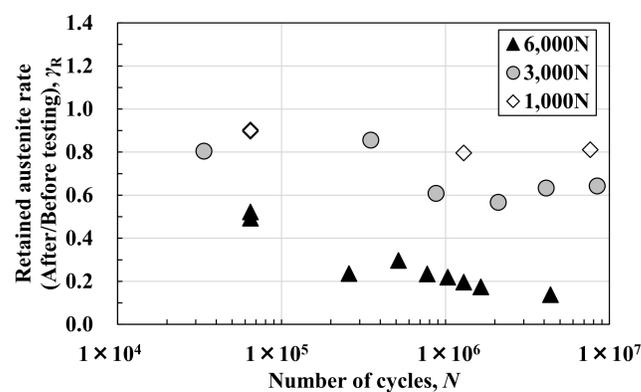
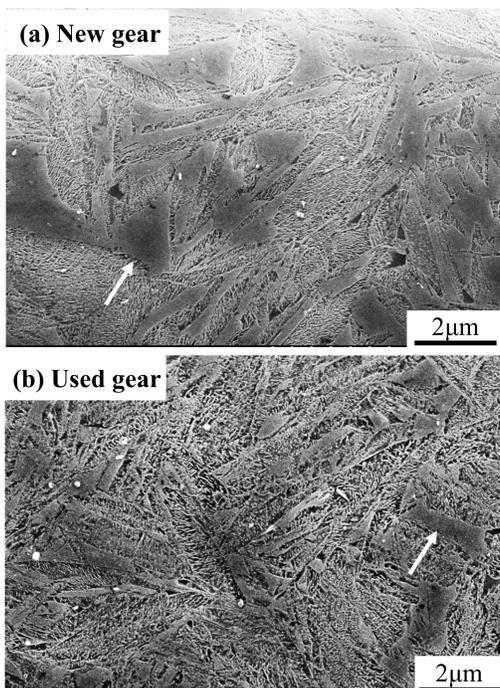


# Review of Damage Evaluation and Remanufacturing for Material Sustainability

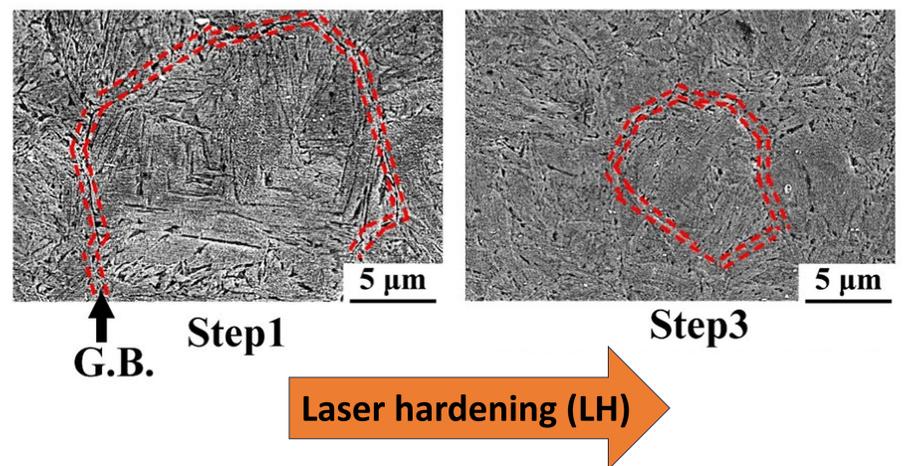
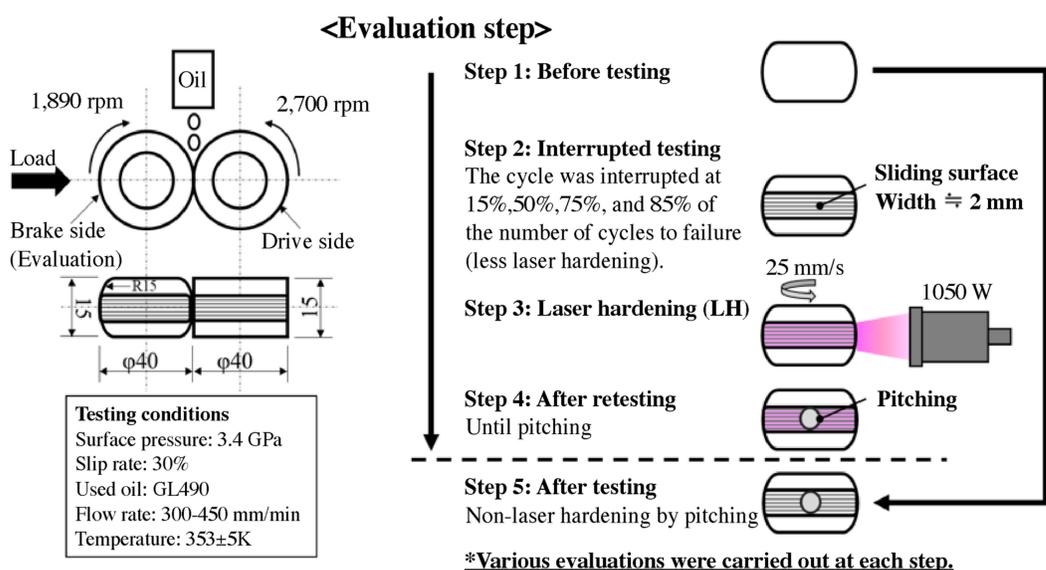


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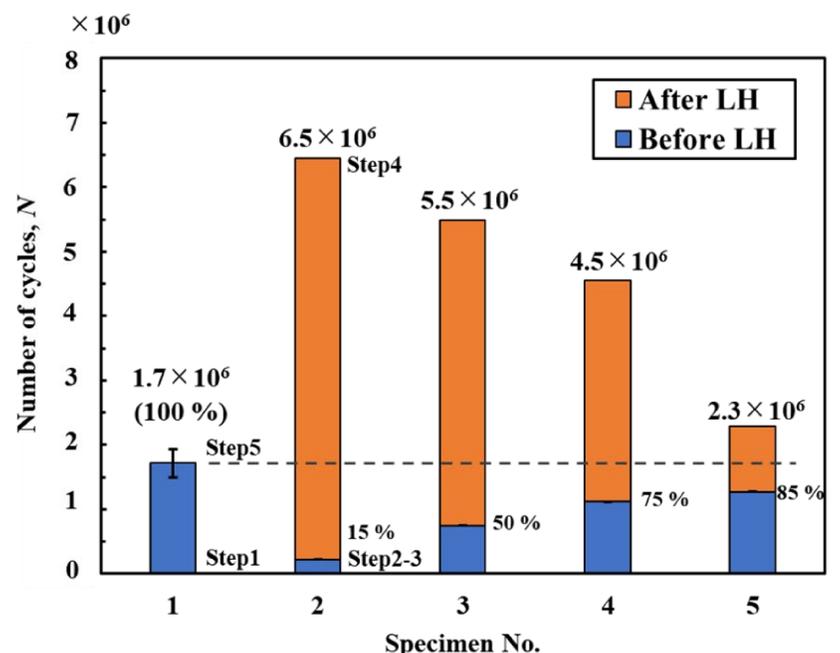
Product remanufacturing offers a path to achieving the United Nation's sustainable development goals. In the rapidly expanding construction-machinery industry, remanufacturing can reduce environmental load and maintenance costs. Although hydraulic components and engines are often remanufactured, **carburized parts, such as large gear parts and the bearings** in reducers or transmission systems, are frequently scrapped. Reusing these expensive parts would significantly increase their value; however, doing so entails the development of techniques for non-destructive testing and functional recovery.



The rate of change in the retained austenite phase and residual stress measured by X-ray diffraction (XRD), appears to be proportional to microcracking in the surface layer. The rate of change in both the retained austenite phase and in residual stress can therefore be used as a safe-side criterion for determining reusability.



Nondestructive measurements of the gear parts using XRD ( $\mu$ -X360s ;  $\cos\alpha$  method)



The development of functional recovery technology for surface treatments is crucial for remanufacturing. Laser hardening to allow the repair of friction-fatigue damage in used carburized martensite steel gears. In addition, prior austenite grain refinement and restoration of the retained austenite phase in the laser hardening quenched layer were realized for the friction-fatigued specimen.