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Residual Stress Characterization using Synchrotron XRD for the Development Laser Shock Peening Applied to Steam Turbine Blades

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The lifespan and integrity of critical metal components such as steam turbine blades for the power generation industry can be limited and compromised by mechanisms such as fatigue and stress corrosion cracking. Conventional surface treatments such as shot peening and roller burnishing are commonly used to introduce beneficial compressive residual stresses to mitigate crack related phenomena. Laser Shock Peening (LSP) is an advanced surface enhancement process that potentially achieves superior performance compared to conventional treatments due to deeper levels of compressive residual stresses. Although LSP has successfully been adopted in the aerospace sector for titanium blade performance enhancement, the technology is not yet typically applied for power generation applications. Systematic development of the LSP process parameters applied to 12Cr steels for low pressure stream turbine blades has been performed using a number of complimentary residual stress characterization techniques such as synchrotron XRD, laboratory XRD, incremental hole-drilling, neutron diffraction, and the contour method. High energy synchrotron X-Ray Diffraction performed at the ESRF (beamline ID15A experiment ME1440) has allowed for qualitative evaluation of a number of LSP parameter combinations leading toward the selection of an optimized parameter combination to be applied to full scale components.

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