CURTISS-WRIGHT

Laser Peening

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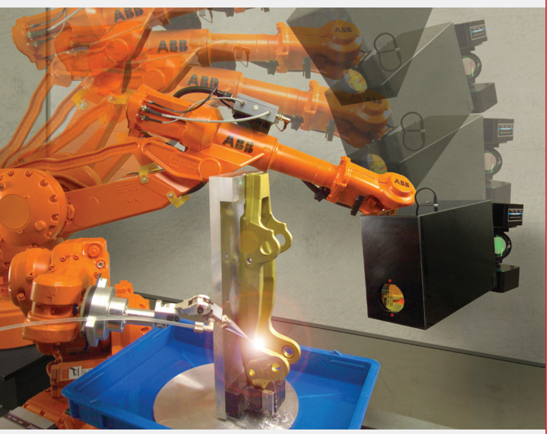
COMPANY PROFILE

Curtiss-Wright Surface Technologies (CWST) offers a single source solution and point of contact for all your surface treatments. We can reduce your turnaround times and costs through our network of over 75 worldwide facilities.

Our proven surface treatments meet industry demands for lighter materials, improved performance and life extension in key markets such as Aerospace, Automotive, Energy and Medical. We can prevent premature failures due to fatigue, corrosion, wear, galling and fretting.



Surface Technologies is a Division of Curtiss-Wright (NYSE:CW) a global innovative company that delivers highly engineered, critical function products and services to the commercial, industrial, defense and energy markets. Building on the heritage of Glenn Curtiss and the Wright brothers, Curtiss-Wright has a long tradition of providing reliable solutions through trusted customer relationships.

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Laser peening induces exceptionally deep residual compressive stresses to increase the fatigue strength and lifetime of metallic components.

The technology surgically places residual compressive stress with accuracies in the range of 0.1 mm into key component areas to retard crack initiation and growth and improve fatigue lifetime and resistance to stress corrosion cracking.

Laser peening will reduce erosion of components such as gas and steam turbine blades from water droplet impact and provides similar protection against cavitation erosion in marine and fluid flow applications.

Laser peen forming performs the same generic role as shot peen forming but because of the greater depth of plastic deformation, extends the degree of curvatures and stretch, enabling more fuel efficient profiles such as high-speed machined/integrally stiffened panels (>25 mm thickness) to be shaped in multiple dimensions. The process is also used to correct the shape of components previously scrapped because they did not meet critical dimensional tolerances.

Potential applications have also emerged for automotive, nuclear waste storage, petroleum drilling and medical implants.

Recent development of a finite element analysis (FEA) code model of the process has allowed evaluation of stress profiles and strains of components prior to and following laser peening.

Laser peening is not a replacement for controlled shot peening, rather it enables process selection based on required performance and lowest cost. This may include a hybrid solution of laser peening for deepest stress combined with shot peening for the highest surface stress.

- Considerably less cold work enables greater retention of residual compressive stress in high load and/or very high thermally challenging conditions
- Deeper residual compressive stress enables better resistance to:
    - low cycle, high stress situations (LCF)
    - high cycle, low stress situations (HCF) in a deteriorating surface environment
    - erosion, strike damage, fretting, stress corrosion cracking and overall corrosion
- Lack of shot particles using “clean” technology enables applications where contamination and/or media staining cannot be tolerated
- Low roughness surface finish and topography reduces manufacturing costs for surface finishing
- Precision robotic peening placement and shot-by-shot control enable excellent process and quality control (FAA and EASA certified)
- Transportable systems for field work

The process

In the laser peening process a Nd:glass laser projects an output beam of roughly 20 Joules at 18 nanoseconds through a flowing thin deionized water layer onto the metal surface.

The area to be peened can be covered with material such as adhesive-backed

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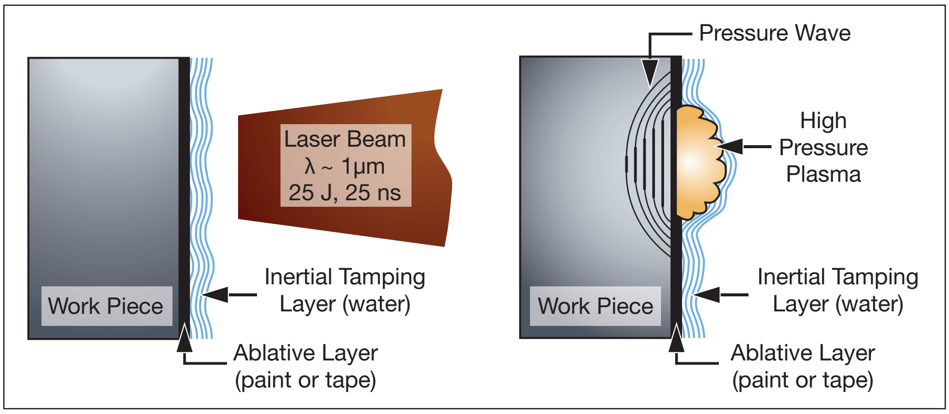
aluminium tape to act as an ablative layer and simultaneously as a thermal insulating layer. Alternatively the peening can be carried out directly onto the base metal which removes and subsequently recasts microns of ablated surface material which in general is easily removed to provide a fully compressive surface.

The leading temporal edge of the laser pulse is absorbed on the base metal surface or ablative layer, rapidly forming a plasma that is highly absorbing for the rest of the laser pulse.

The inertia of the water layer confines the plasma volume resulting in a rapid pressure rise to levels as high as 100 kBar. This rapid rise in pressure effectively creates a shock wave that plastically strains as it penetrates deep into the material. The peak pressure can be controlled by adjusting its footprint size in order to achieve a level of one to two times the dynamic yield stress level of the material being peened.

As in all peening, plastically straining the material normal to the surface, results in transverse expansion of the peened area.

If the geometry of the area being peened is stiff and resists the expansion, a residual compressive stress field develops which can extend to a depth of between 1mm and 8mm depending on the material and the processing conditions. This deep level of compressive stress creates a damage tolerant layer and barrier to crack initiation and growth, which consequently enhances the fatigue lifetime and provides resistance to stress corrosion cracking, erosion and fretting fatigue.

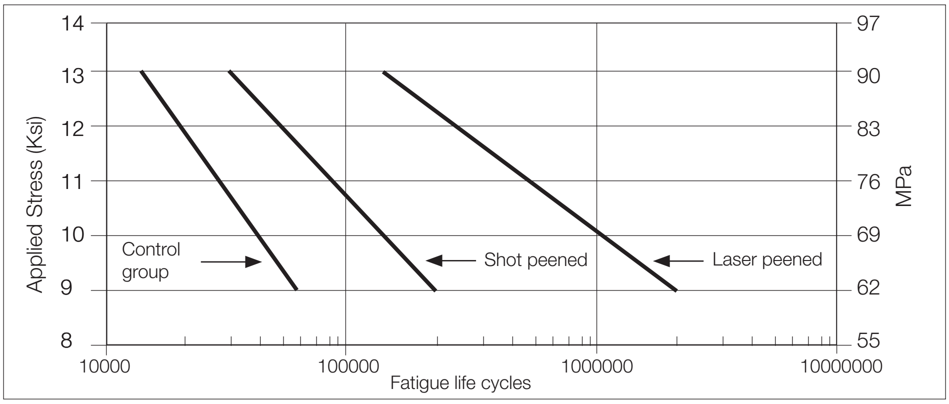


If the geometry allows expansion then forming such as wing panels for aircraft or corrective forming of structural parts can be achieved.

Test results for Al6061-T6

The benefits of peening with the advantages of an exceptionally deep residual compressive layer are shown below in test results for Al6061-T6. The S-N curve shows fatigue test results for unpeened, shot peened and laser peened specimens. The chart shows that shot peening provided approximately 360% increase in fatigue lifetime and that the laser peening provided a very impressive 3600% increase. From the point of view of fatigue strength improvement, the shot peening provides a 30% increase in strength and thus potential of equivalent weight reduction and the laser processing provides a 40% increase beyond the shot peening or an overall potential of 70% reduction in cross-sectional area in the stressed area.

Laser Peening of Al6061-T6



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