INNOVATORS IN TECHNOLOGY

Metal Improvement Company

Subsidiary of Curtiss-Wright Corporation

Laser peening

Component protection

Enhancing the performance of metals and materials

www.metalimprovement.co.uk

CURTISS WRIGHT

Laser peening enhancing the fatigue strength of critical metallic components

Metal Improvement Company (MIC) is a global organisation specialising in metal and material surface treatments which enhance performance and extend the life of critical components, enabling component designs to achieve their maximum potential.

Established in 1945, MIC has over 60 operating divisions in Europe, USA, Canada and Asia with on-site processing worldwide. We offer a quality controlled and cost effective service, working in partnership to meet our customer's needs.

MIC division approvals, where appropriate, include: FAA, AS9100, NADCAP, ISO 9001:2000, ISO 9001:2008 plus other specific OEM, company and industry approvals as required.

Metal Improvement Company is a subsidiary of the Curtiss-Wright Corporation, a diversified international provider of highly engineered products and services to the Motion Control, Flow Control and Materials Treatment industries.

www.curtisswright.com

CURTISS WRIGHT

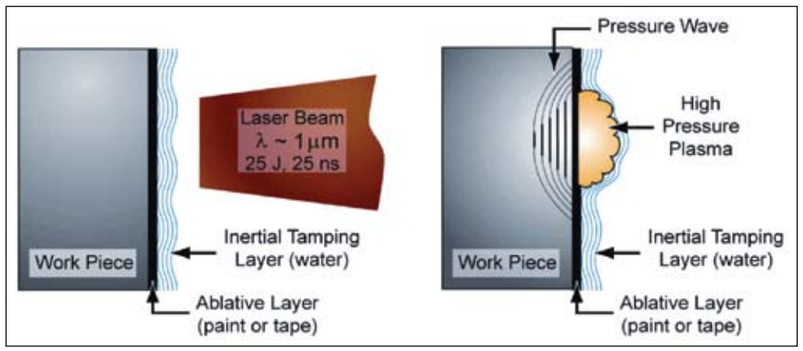
Laser peening induces exceptionally deep residual compressive stresses to enhance the fatigue strength of critical metallic components.

Laser peening is making an important impact on industry following the major transition from a laboratory research and development activity to a reliable and production qualified technology. Laser peening offers designers the ability to surgically place residual compressive stress into key areas of components to retard crack initiation and growth enabling increased fatigue strength ratings.

Laser peening is not a replacement for controlled shot peening, but has additional advantages that can influence which method to use:

- Deeper residual compressive stress enabling better resistance to:
  - low cycle, high stress situations (LCF)
  - high cycle, low stress situations (HCF) in a deteriorating surface environment
  - erosion, strike damage, fretting and corrosion
- Considerably less cold work enables greater retention of residual compressive stress in high load and/or thermally challenging conditions.
- Lack of shot particles using "clean" technology enables applications where contamination and/or media staining cannot be tolerated.
- Original surface finish and topography more easily maintained and controlled.
- Allows for excellent process and quality control.

The technology of laser peening is shown below:



The Process

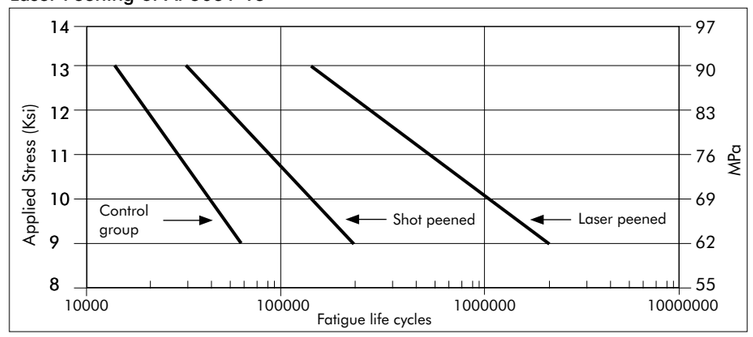
An output beam, roughly 25 Joules at 18 nanoseconds from a Nd:glass laser is projected onto a work piece to induce a residual compressive stress. The area to be peened can be covered with material to act as an ablative layer and simultaneously as a thermal insulating layer, or peened directly onto the base metal which subsequently may require some form of surface removal of a few microns.

A thin stream of water is made to flow over the surface and the laser light transparently passes through the water, the leading temporal edge of the laser pulse is absorbed on the metal surface or ablative layer. This absorption rapidly ionizes and vaporizes more of the surface material to rapidly form a plasma that is highly absorbing for the rest of the laser pulse.

A high plasma builds to approximately 100kBar (1 million pounds per square inch) with the water serving to inertially confine the pressure. This rapid rise in pressure effectively creates a shock wave that penetrates into the metal, plastically straining the near surface layer.

The plastic strain results in a residual compressive stress that penetrates 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 a barrier to crack initiation and growth, which consequently enhances the fatigue lifetime and provides resistance to stress corrosion cracking and fretting fatigue.

Laser Peening of Al 6061-T6



Multiple firings of the laser in a pre-defined surface pattern will impart a layer of residual compressive stress at and below the surface. The process can be tailored to suit the product and potential failure mechanism or enable higher potential loads through weight sensitive designs.

The benefits of an exceptionally deep residual compressive layer are shown above. The S-N curve shows fatigue test results of 6061-T6 aluminum. The testing consisted of unpeened, shot peened and laser peened specimens.

APPLICATIONS

Laser Peening has been used for several years to prolong the fatigue life of critical aerospace components such as turbine engines and aircraft structures but is now being used to peen form wing skins to achieve the requirements of the new generation of intercontinental aircraft. Laser peen forming essentially performs the same role as shot peen forming, but because of the greater depth of plastic work, extends the degree of curvatures possible enabling more fuel efficient profiles to be achieved.

Potential applications have also emerged for automotive, power generation, nuclear waste disposal, petroleum drilling, medical implants and recreational sports.

With facilities in the United States and UK, MIC also operates a mobile laser peening unit which enables us to bring this technology directly to our customers on site.

MIC MARKETS INCLUDE:

- **Aerospace**
- **Architectural**
- **Automotive**
- **Chemical & food processing**
- **General & structural engineering**
- **Marine**
- **Medical**
- **Military**
- **Off-road & earth moving equipment**
- **Oil, gas & petrochemical**
- **Power generation**
- **Railways**

MIC SERVICES INCLUDE:

- **Controlled shot peening**
  induces engineered residual compressive stresses
- **Shot peen forming**
  creates curvature and corrects distortion
- **Laser peening**
  induces deeper residual compressive stresses
- **Engineered coatings**
  improves performance, prevents corrosion and aids lubricity
- **C.A.S.E. (isotropic finishing)**
  removes surface asperities reducing friction
- **On-site processing**
  provides services on customers' own premises
- **Peentex (architectural finishing)**
  creates decorative and aesthetic texturing
- **Surface texturing**
  applies a textured engineered finish
- **Peenflex mouldings**
  protects against processing and handling damage

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