

# Laser Transmittance Enthalpy Selective Component Development

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## ABSTRACT

Components of high density, volume to weight ratio and enthalpy were known to withstand significant transformation in laser manufacturing. In most situations, both sides could be textured for dual fitting and allowance of longevity of the part in use. This research investigates the redesign of non-axisymmetric and symmetric parts fittings. These were typically used in joints that were high compressive and tensile in motion. The degrees of freedom in both the clockwise and anticlockwise joints were known to minimize the service life of non-planular joints. The results of this study were to prevent non-slippage of the joint and improve load balance performance. In conclusion, planular joints, especially structural mechanics, were implemented in high supportive design, in particular, where both sides were textured. In the implication, the laser would have to be used with the purpose of reduction of enthalpy and improvement of surface density of the components.

**Keywords:** Planular, Joints, Dual, Surface Textures, Laser Enthalpy

## INTRODUCTION

Planular components were known to have low residual surface density after manufacturing [1-5]. This ensured a high supportive load carrying capacity. But due to this there was an enthalpy resultant depleted to give rise to failure in the presence of external loads such as high winds speeds and impact factors of the environment [6,7]. Dissimilar to axisymmetric joints such as shafts and pinions. These did not resist horizontal loads, such as erosions of external layers.

Planular joints were mostly used in structural fittings, such as supports under bridges [8]. These were known to corrode over time, and axial winds, and tidal impacts affected their stability. However, shafts and pinions had a high residual concentration. This led to their deterioration over time due to compressive and load support. Therefore, reduced service for high load carrying capacity.

In this research, the aim was to produce a methodology for the development of planular mechanisms using lasers

of picoseconds capacity [9-46]. The objective was to avoid exceeding the enthalpy whilst ensuring the surface strength and integrity of the joint. The importance would be a high load carrying capacity for fittings of centimeter to a millimeter's thickness.

## METHODOLOGY

### Materials

Three sets of materials made from high width to depth ratio were used for experiments. These were dimensions of 15mm depth, 70mm width, and 70mm lengths. The material used consisted of zirconium material. The purpose was to produce three different texturing scenarios. In the initial instance, the texture was applied on the upper side, the second on both the upper and lower side, and the third on the lower side of the material.

These were to be fitted in an aperture opening with an allowance of 2.5mm for high tensions along its length. The effect was to have the external component textured internally using a CNC tool. After this, the components undergo insertion and removal tests with increments of 5N, and a maximum load applied of 500N.

The laser was supplied in literature in a single pass. This did not give sufficient peaks and depths to the material. Therefore, reduced the smoothness giving rise to distortions and finally disassemblment of the joints.

In this research, to ensure sufficient transformation of the enthalpy without exceeding the thermal coefficient, three passes of a laser picosecond were applied. This had a low wavelength in the span of 10-12/s. The laser was then studied for distortions and elastic modulus in each of the three scenarios and profilometric testings for smoothness. To determine its performance and if further additive processes were a requirement.

## RESULTS

In this study, the laser objective of picosecond observation of each of the three scenarios gave different effects. The external material surface for both the upper and lower textures only showed high discoloration. The laser surface produced similar peak heights and depths for all three scenarios. The discoloration was highly stable for the specimens textured on both sides at the same time. This was due to the greater laser density absorbed by the material. The peak asperity was

highly visible in all three scenarios; both were developed by up to three passes of the laser picoseconds.

The effect was the abrasion of the surface layer coating reflective to produce the inner layer, which was highly malleable for the formation of asperities. This was necessary to improve the surface contact area due to the irregular region and low smoothness of the external material.

The high contact area allowed high joint forces to be transmitted between the contact surfaces to support the loading of the non-contact forces.

## DISCUSSION

The scenario produced three different phases of the material. In the first and third instance, the material was converted to another form of a state known as  $\alpha'$  phase. This had almost the same structure as the  $\beta$  state but had a lower enthalpy than the previous two states. The effect was a higher ductility but not a higher brittleness of the material. The second scenario produced a higher laser transmittance, giving rise to a complete phase change to the  $\beta$  phase. This was an improvement in the literature to ensure visible surface asperities as only a femto laser could achieve the depth and width due to its low spot size of wavelength  $10^{-15}$  /s. Therefore, greater depth for the laser density used for the application.

### Laser Joint Forces

In the second experiment, the materials were tested for joint forces. Each of the specimens was held and inserted at an increment of 5N to a maximum load of 500N testing apparatus. These were then performed in different supply directions for up to 9 times according to factorial experiment of number of factors number of experiments. The effect was up to three responses from experiments.

The extensometer was used to obtain the measurement of the joint strength and loading strength of the components. The experiment showed that the upper texture had low joint strength and loading strength. This was due to the texture and applied loading in the direction of gravity. Therefore, there were low residual stress concentrations to reduce the unloading of the joint.

In the second, scenario the both the joint strength and unloading strength were high and balanced to the equal forces of gravity in compression application on the textures. The effect was an optimal joint. This was capable of supporting

loads and durable for longevity in use and service life.

The third specimen a dissimilar to the two. The unloading strength was loaded but the joint strength of the material was high. This gave rise to a component with high replacement but low durability and life of the joint.

### Elastic Modulus

The elastic modulus was measurement using a pinion test. A load of the 50N bar bels was applied in intervals of 5 seconds on the material. The reactive forces were repelled by the pinion. The galvanometer attached measured the elastic modulus.

The effect was in the initial test material that there were distortions and irregularities in the surface area. The elastic modulus was a fourth of the manufacture's specification after laser surface texturing and loading tests. The abrasion of the material due to the loading and materials phase state reduced the ductility and hence the elastic modulus change.

In the second situation, the elastic modulus was found to have risen to two thirds of the manufacturer's specification. The loading and unloading had minimal effect on the elastic modulus after the start and after the joint tests.

In the third material, the pinion measurement determined the elastic modulus to have increased to only a third of the manufacturer's specifications. To produce a material of higher ductility and lower brittleness than the initial specimen but lower performance than the second specimen in the experiment.

### Surface Profilometry Tests

In this experiment, the surface smoothness was measured using a stylus of a profilometer. This was placed across the material surface. To determine the materials irregularities. For further studies of the materials, aesthetics, and durability. This was to avoid initiation of loss of joint strength due to low smoothness in the unloading and loading of the joint material.

The effect was that the initial material had high smoothness due to the reactive forces applied from the gravitational forces on the specimen. The material surface had the lowest particular residue sizes. The second material had the second largest residual particulate sizes due to the high compressive forces and tensions forces. The third material had the highest abrasion to the gravitational forces and the direction of the surface textures on the material.

### CONCLUSION

In conclusion, each material gave three different scenarios. The highest performance was from the surface texture on both sides of the pieces. This ensured stability upon loading and unloading and redirected the surface residue formation on the joint. Therefore, it allowed repeated joint strength and replacement of the joint. The laser methodology ensured the material was durable and produced visible textures with similar number of passes to the femtosecond lasers using the picosecond wavelength. The effect was a higher surface area capable of ensuring the joint strength was not depleted over time. The phase of the second material showed a greater amount of transformation. Therefore, it had a higher ductility and performance whilst in use and a smoother surface area to ensure distortions were low in the material.

### CONFLICTS OF INTEREST

The author declares no conflicts of interest.

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