# Two-Level Security Marking for Anti-Counterfeiting Applications


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## Introduction

Laser marking and engraving is a fundamental procedure that is used by a range of industries to trademark and protect their products. Micro marking in particular is a form of laser marking that is used to combat the counterfeiting of products. An example of this is the new one pound coin from 2017.

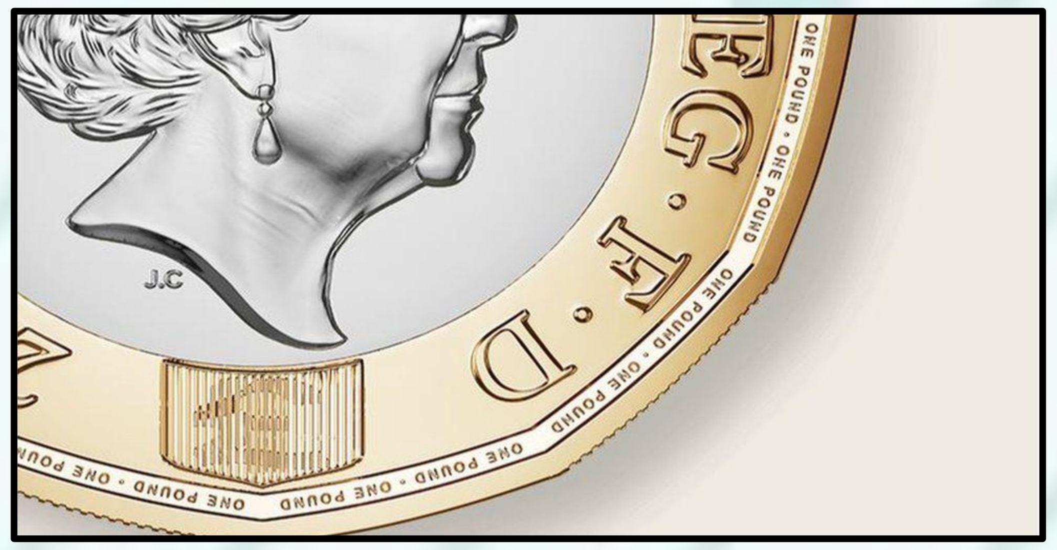

Figure 1 – Micro marking is used on the one pound coin as one of its security features.
Source: https://www.bbc.co.uk/news/business-39409313

- Nearly 10% of all goods worldwide are counterfeit in some way or another [1].
- Laser marking has now become a routine operation for manufacturers to protect products from duplication – however is limited to microscale resolution.
- The ability to mark nanoscale features in addition to the micro-marking would greatly enhance the anti-counterfeiting security.

## Summary of Aims and Objectives

- Use the nanosecond fiber laser to generate microscale markings on stainless steel and Aluminium surface samples.
- On top of micro marking, adding colour markings and/or nano markings as a second-level security feature.
- Using particle-lens for nano marking and study particle size effect on nano marking.
- Study colour marking on stainless steel and the parameters that cause different colours to be produced.


## Acknowledgements

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[1] Fighting counterfeiting at the nanoscale. Nat. Nanotechnol. 14, 497 (2019). Available: https://doi.org/10.1038/s41565-019-0484-0 Accessed[14/10/2020]

[2] S. Alabrahem, "Investigation of Laser Colour Marking and Nano Marking Technology", Master of Science, Bangor University, 2016. Accessed[03/11/2020]


## Implementation & Approach

- Before experimenting, the steel needed to be prepared so was sanded down to remove any surface scratches before marking onto the surface.

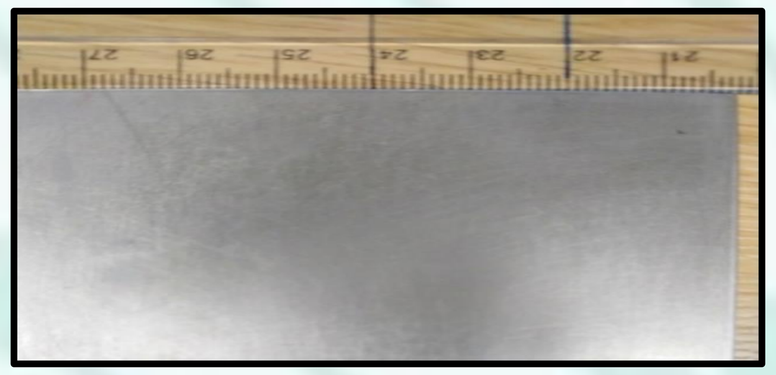

Figure 2 – A sample of Stainless Steel after treatment

- The Laser used to create the markings onto the stainless steel and Aluminium was a LMT2000P nanosecond fibre laser whose parameters were controlled using the Ezcad software.

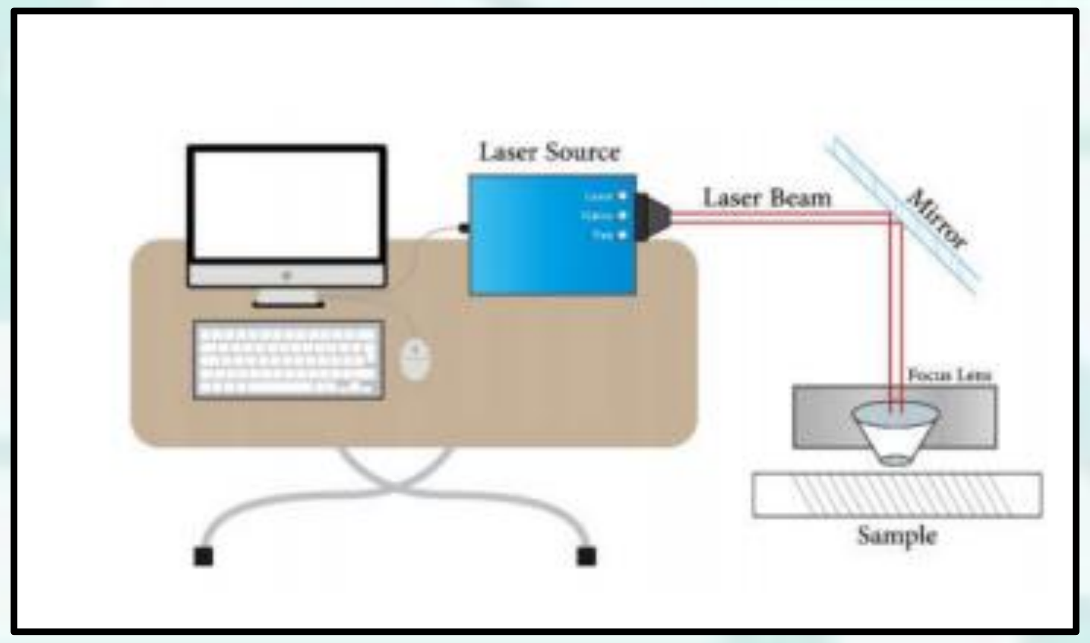


Figure 3 – Experimental setup of Laser [2].

- The first series of experiments studied the relationship between line width and laser power at microscale resolution.
- In a separate experiment, 15µm and 80µm sized particles were placed on an Aluminium surface. These particles leave behind nano-sized "holes" when they interact with the laser light – potentially providing an additional security feature.
- The markings were then imaged using a Olympus DSX1000 Digital Microscope where they were viewed with 10X magnification to study the markings in detail.

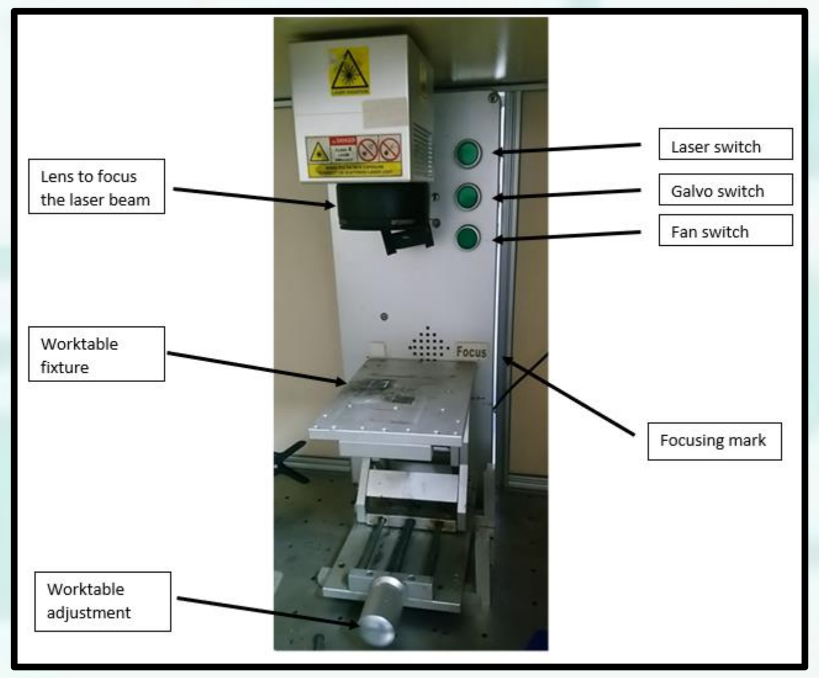


Figure 4 - Front side view of LMT2000P nanosecond fibre laser machine

Figure 5 -Front side view of the Olympus DSX1000 Digital Microscope

## Results

- Figures 6 and 7 display the variation of line thickness against laser power.

| Power (%) | Average Line Thickness (µm) |
|---|---|
| 100 | 127.845 |
| 90 | 122.879 |
| 80 | 114.22 |
| 70 | 101.873 |
| 60 | 94.495 |
| 50 | 88.214 |
| 40 | 77.019 |
| 30 | 68.002 |
| 20 | 55.024 |
| 10 | 44.745 |
| 1 | 36.092 |

Figure 6- Table of Average Line Thickness against Laser Power

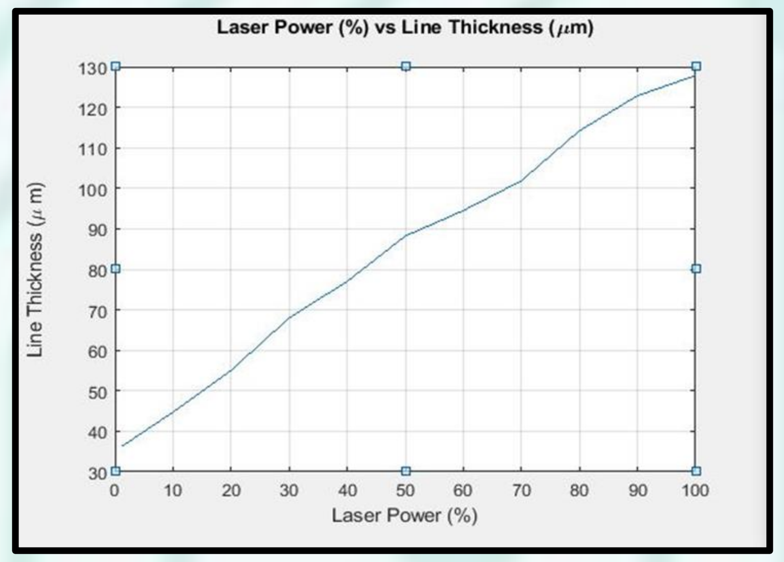


Figure 7 – Graphical plot of Data from table in Figure 5

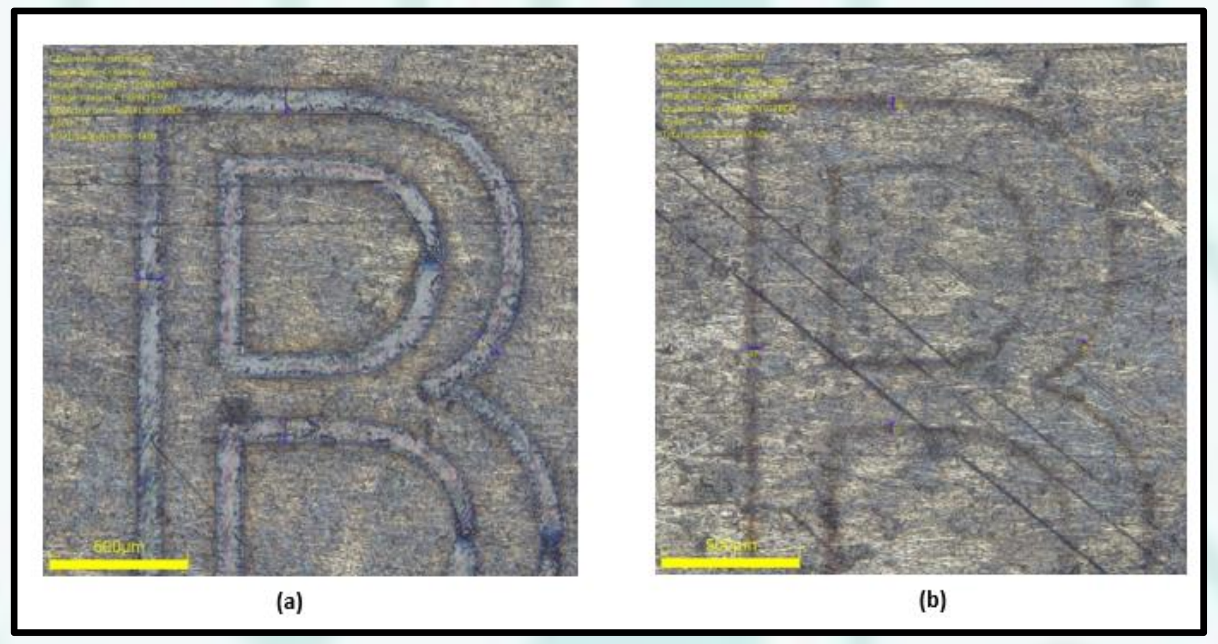


Figure 8 - Comparison of markings at a) 50% and b) 1% Power

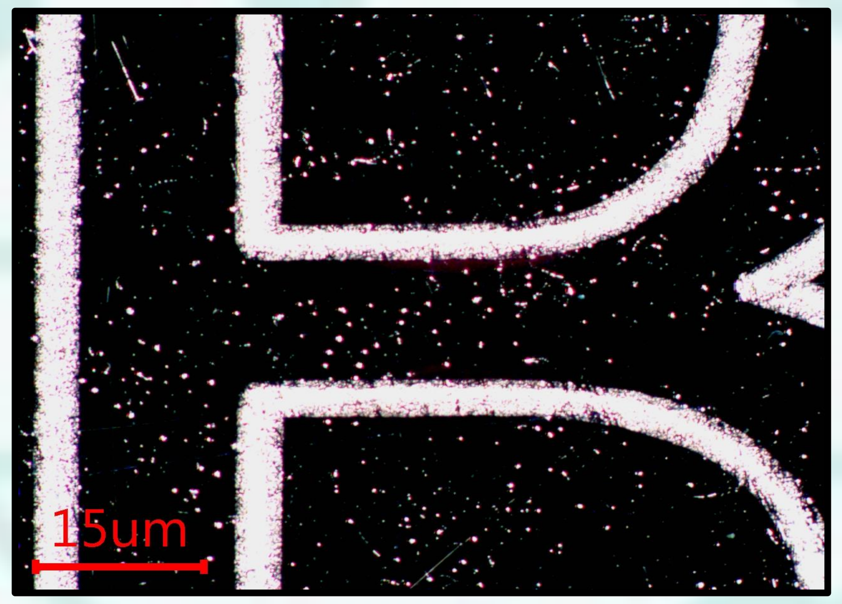


Figure 9 – Holes produced from 15µm particles after marking on Aluminium

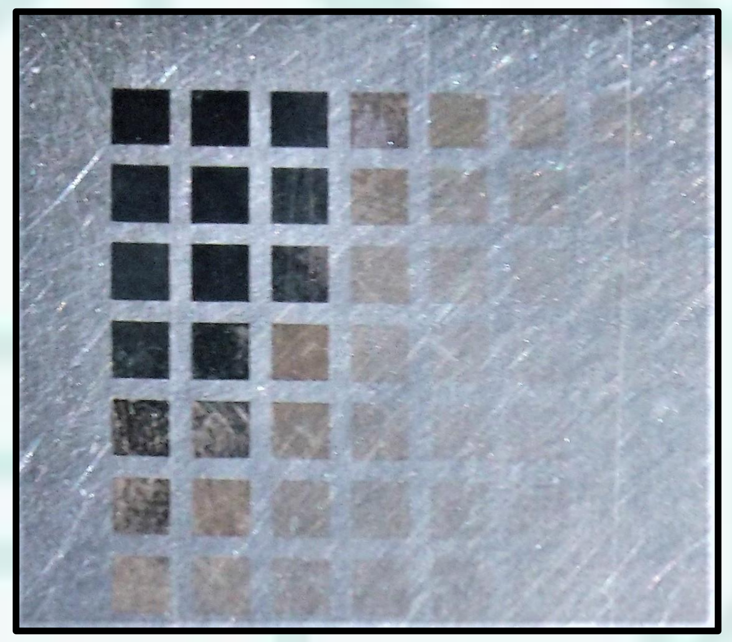

Figure 10 – Colour marking on stainless steel

## Conclusions

- An average reduction of 8.341µm in line width occurred for every 10% drop in power.
- Scanning speed and Power affect the colour produced on stainless steel due to its oxide layer but needs to be optimised further.
- 15µm particles produced significantly more "holes" compared to the 80µm holes.
- The process of combining micro-marking with nano-marking and/or colour-marking are under further optimisation.