Laser Modification of 2G-HTS Tapes Surface

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Introduction

Lasers are powerful tools to modify materials surfaces and to produce a controlled set of defects. In this study, second generation high temperature superconducting (2G-HTS) tapes are scanned with pulsed ps-UV and ns-IR lasers to generate a uniform micro and nanostructure on the surface of these tapes.

We have been studying the influence of several parameters that are important in laser processing. When the burst mode is used, individual dots are created in the surface of the superconductor. We have analysed the influence of the energy of each individual laser pulse and the number of pulses. We have determined which is the minimum energy to start to affect the superconductor and which is the energy level that completely destroys the superconducting layer. This allows defining the range of working conditions that can be used in these experiments.

Which Laser?

ps-UV and ns-IR lasers were used to introduce some micro- and nano-structures in the surface of superconducting thin films. The effect of the two lasers was compared by performing pulse deformations corresponding to the same energy values. Calculated energy values and hole width measurements of deformation are given in the following figure.

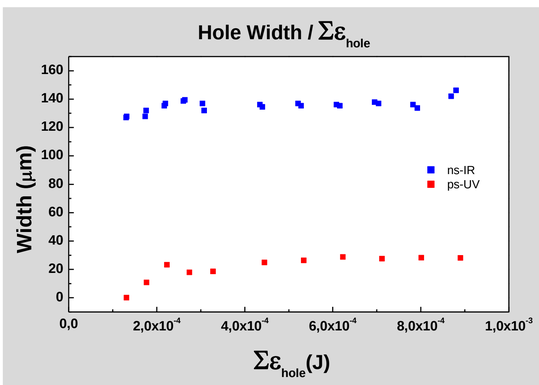

Figure 1. Plot of hole width versus energy

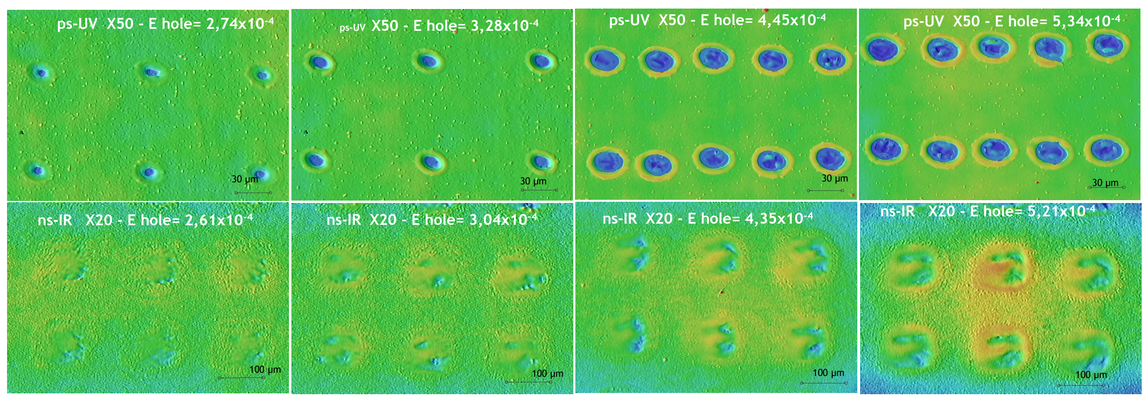

Figure 2. Confocal Microscope images of pulse deformations corresponding to the same energy values using ns-IR and ps-UV lasers

When the ps-UV laser was used, well-defined holes were formed on the surface. In contrast, the ns-IR laser induced melting of the surface and a non-uniform surface deformation was produced. In consequence, it is not possible to obtain a controlled, uniformly distributed nano-scale deformation on the surface using the ns-IR laser.

Wobbling Mode: Controlling the laser parameters in the wobbling mode, uniformly distributed deformation is induced in the sample surface.

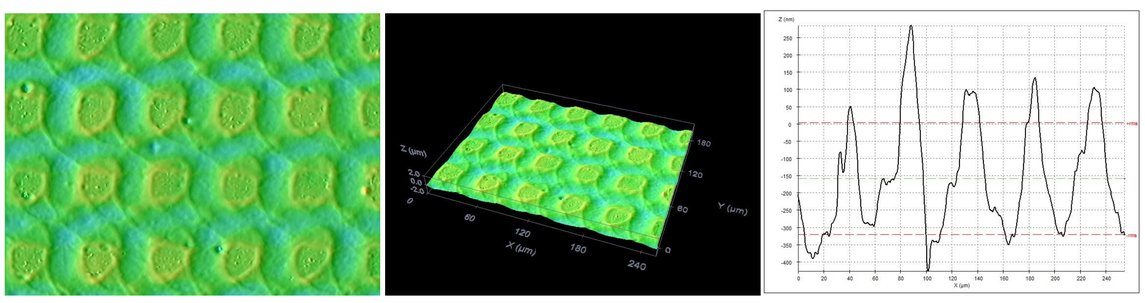

Figure 3. Confocal Microscope images of deformation created by wobbling mode on YBCO thin film

Scanning mode: Lines can be generated in the desired direction with controlled intensity using the laser scanning mode. When the energy density is increased, only the depth increases, while the line width remains nearly constant (≈22µm).

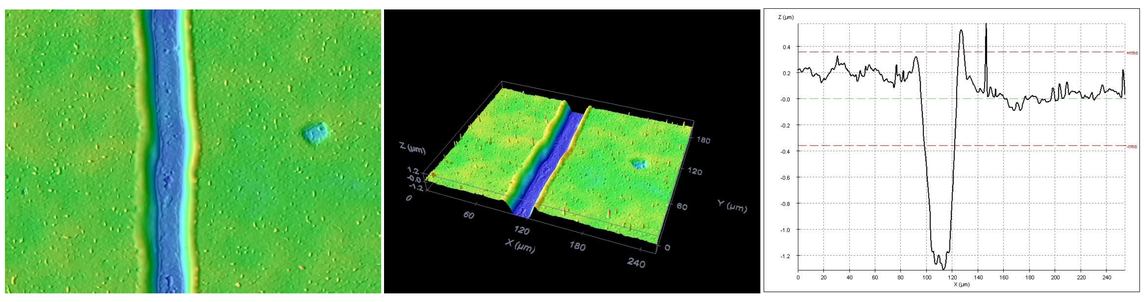

Figure 4. Confocal Microscope images of line created on YBCO thin film

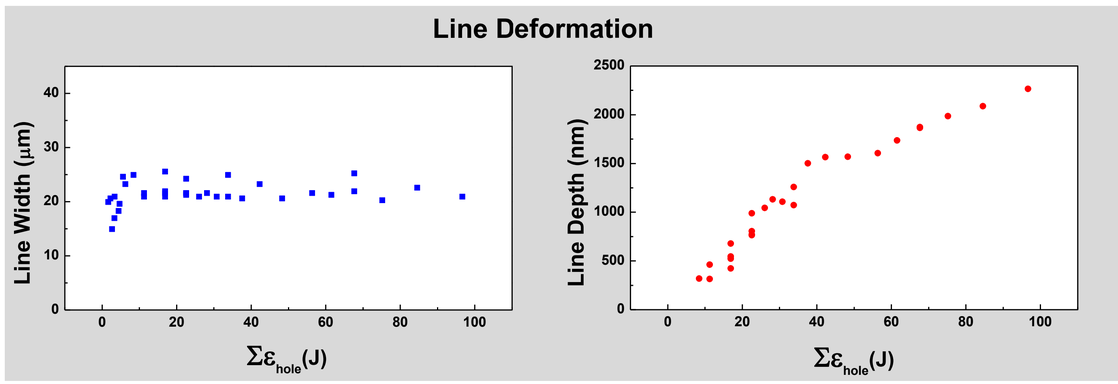

Figure 5. Plots of line dimensions versus laser energy

Burst mode: Using the burst laser mode, micro scale uniform holes can be generated on the surface of the superconductor.

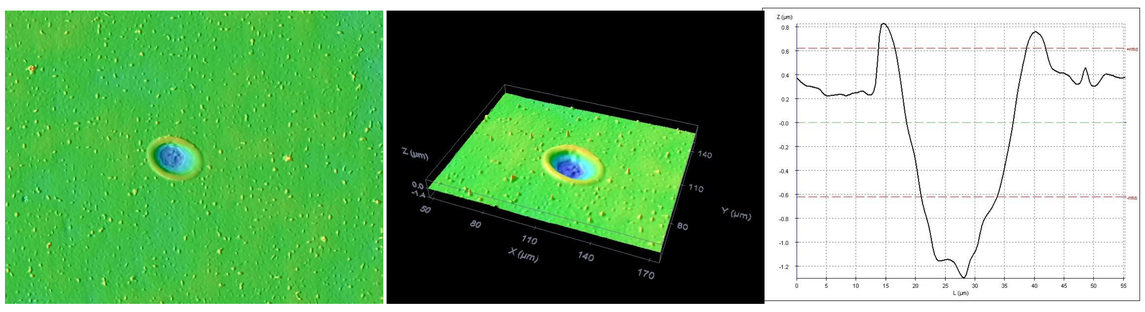

Figure 6. Confocal Microscope images of pulse of a typical hole created on YBCO thin film

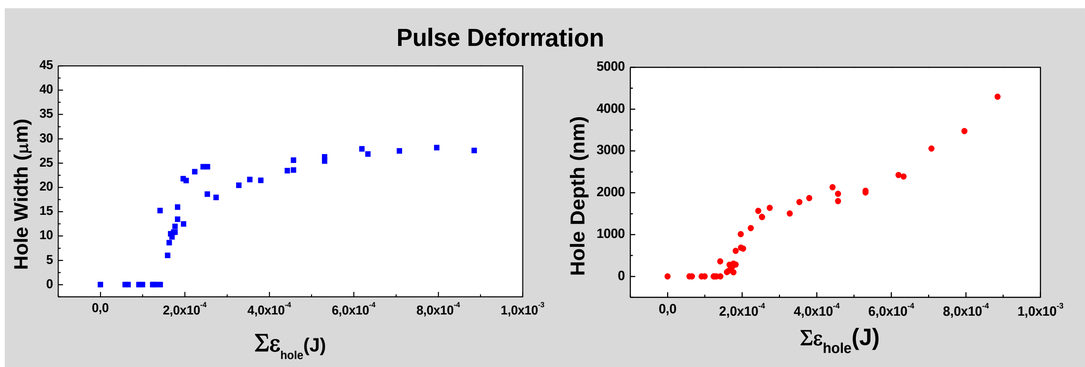

Figure 7. Plots of hole dimensions versus laser energy

Results:

- By choosing the appropriate parameters with the ps-UV laser, controlled, micron-sized deformations can be created on the YBCO film.
- it has been seen that all the deformation depth versus energy graphs have a plateau around 1500 nm. With this analysis it is possible to determine the range of energy density that can be used to modify the superconducting layer without affecting the substrate.

Acknowledgements

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