

Characterization of nuclear transmutations by 638 nm laser beams



U. Mastromatteo⁽¹⁾, V. Nassisi⁽²⁾ and G. Caretto⁽²⁾, A. Buccolieri⁽³⁾, G. Buccolieri⁽³⁾, D. Manno⁽³⁾ and L. Famà⁽³⁾

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⁽²⁾ Applied Electronics Laboratory, Department of Physics, University of Lecce, I.N.F.N., C.P.193, 73100 Lecce-I

⁽³⁾ Departments of Material Science, University of Lecce C.P. 193, 73100 Lecce-I

INTRODUCTION

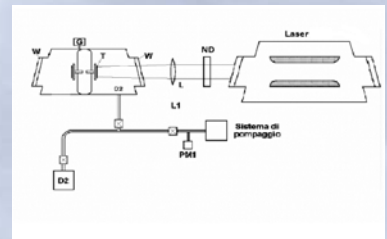
Transmutations of elements observed in palladium films irradiated by cw HeNe laser beams are presented.

METHODE AND EXPERIMENT

The samples used were silicon wafers having a 50 nm Ti layer with a 500 nm Pd layer on it. They were cut in small dies of about 1 cm² and implanted with boron. The Ti layer was necessary to improve the adhesion between the substrate and the Pd layer. A 150 keV accelerating voltage allowed to the B ions to reach a maximum concentration at 158 nm depth in the palladium layer. The chambers used in this experiment was filled by hydrogen or deuterium gas. The maximum pressure was 4 bar. The samples were irradiated at a laser power density of 2 mW/cm². They were processed from July 16th to September 29th 2004. After the treatments the samples were analysed by a Scanning Electron Microscopy (SEM) and an electron probe micro analyser (EDX), followed by a further plasma spectrometer (ICP) analysis. As a control some specimens were kept in air and analyzed in the same way as the processed samples.



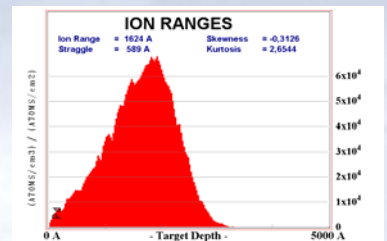
Photo of experimental apparatus.



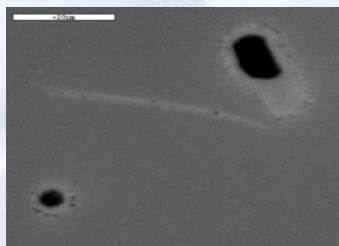
Scheme of experimental apparatus.

RESULTS AND DISCUSSION

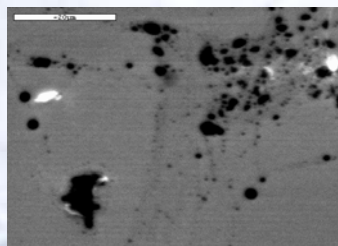
The samples showed morphological modifications compared with those kept in air, which film surface did not change. In the processed samples was evident the presence of many coloured spots (black and white) with sizes varying between 1-20 μm. The density of spots number increases for irradiated samples with respect the non-irradiated ones. Qualitative elemental analysis (EDX) made inside the spots, for both the H₂ and the D₂ loaded samples treated with laser beam, revealed the presence of "new" elements, inexistent in samples not processed. This fact was the sign that elemental transmutation occurred.



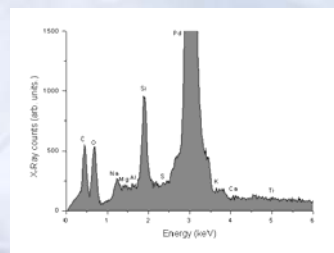
Boron atoms distributions vs. the target depth.



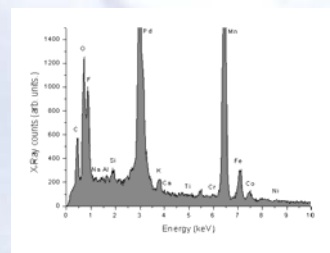
SEM micrograph of the 76 processing days Pd surface without laser.



SEM micrograph of the 76 processing days Pd surface by laser.



EDX Spectrum of a spot on sample processed 76 days without laser.



EDX Spectrum of a spot on sample processed 76 days with laser.

The main detected elements were:

| | H ₂ | | D ₂ | |
|----|----------------|-------|----------------|-------|
| | No-laser | Laser | No-laser | Laser |
| Si | Si | Si | Si | Si |
| Pd | Pd | Pd | Pd | Pd |
| Ti | Ti | Ti | Ti | Ti |
| | C | C | C | C |
| | O | O | O | O |
| | Ca | Na | Na | Na |
| | Na | Al | Al | Al |
| | Cr | S | K | K |
| | Fe | Ca | Ca | Ca |
| | Ni | K | Mg | Mg |
| | Al | Mg | | |
| | S | | | |
| | K | | | |
| | P | | | |
| | Co | | | |
| | Mn | | | |

The cause of the transmutation of elements is not clear. It could be due to the metal electrons (plasmon) or the deformation of crystalline lattice which can increase the fusion probability.

Experimental works are in progress to explain the above results.

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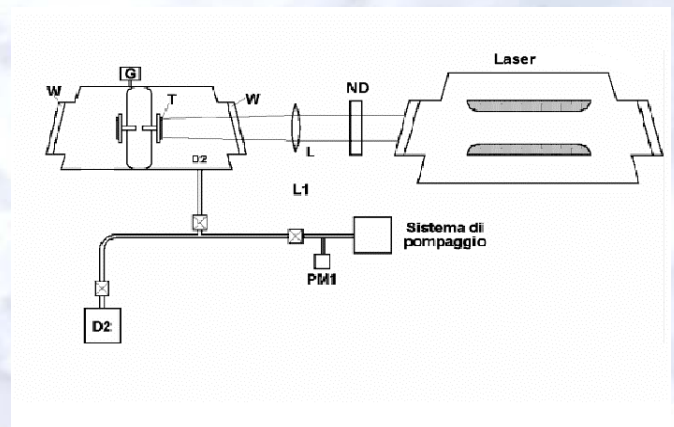
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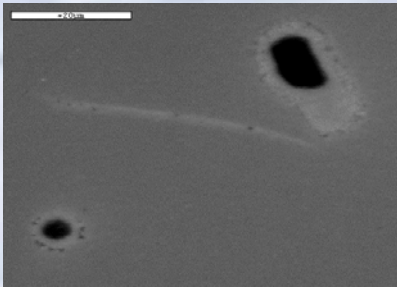
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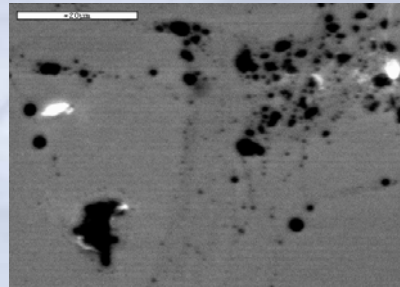


RESULTS AND DISCUSSION

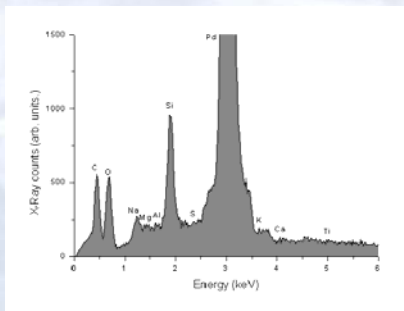
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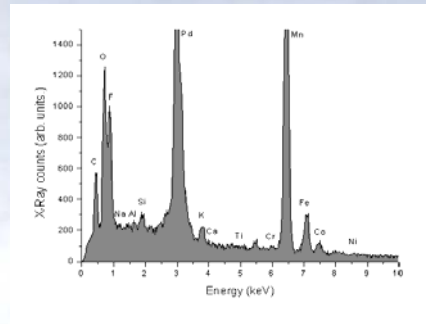
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| H_2 | | D_2 | |
|--------------|-------|--------------|-------|
| No-laser | Laser | No-laser | Laser |
| Si | Si | Si | Si |
| Pd | Pd | Pd | Pd |
| Ti | Ti | Ti | Ti |
| | C | C | C |
| | O | O | O |
| | Ca | Na | Na |
| | Na | Al | Al |
| | Cr | S | K |
| | Fe | Ca | Ca |
| | Ni | K | Mg |
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