Selective removal of graphene by means of micro- and nanosecond laser irradiation.

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Abstract

Selective removal of graphene by laser irradiation allows the complex patterning of graphene films with linewidth resolution in the range of tens of micrometers. Thereby, it may enable the exploitation of its exotic electronic properties in geometry-dependent applications, and makes technologically feasible its integration in microdevices.

To the best of our knowledge, up to the date only femtosecond lasers have been used to address the challenge of facile graphene patterning (see for example [1], [2]). In this work, the use of nano and microsecond laser is inquired, because their lower cost of processing could facilitate the integration of graphene in devices at industrial scale.

Graphene films have been synthesized on copper foil by means of a chemical vapor deposition process using methane as a precursor, as detailed in [3], and afterwards transferred onto silicon oxide substrates by means of the well known PMMA-based transfer process.

With comparative purpose, two different laser sources with pulse widths of microsecond (diode, 1064nm) and nanosecond (Nd:YAG 532nm) were used to scribe pairs of parallel lines on the samples at a separation distance of 70μm.

Series of preliminary tests have been carried out and, on its basis, different conditions have been selected to pattern three samples with each laser.

All the samples were inspected by means of optical microscopy (as in figure 1), and Raman spectroscopy was used to prove the complete removal of graphene in the laser grooves, as well as to determine the grade of graphene damage in areas close to the edges.

Figure 2 shows an example of the Raman characterization carried out, Although the borders of the lines scribed with nanosecond laser were better defined, it can be concluded from Raman measurements that interstitial graphene was more damaged than in the case of microsecond laser scribed samples.

References

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Figures

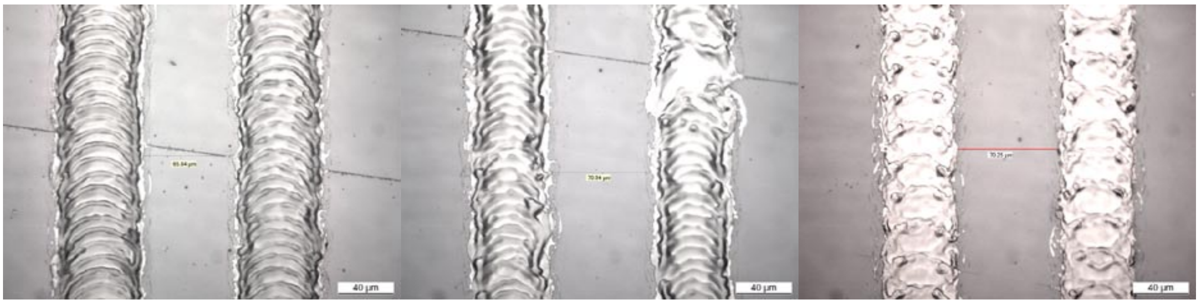

Fig. 1: Optical microscopy images showing examples of the different grooves obtained when varying the conditions of scribing (current, frequency and scan speed).

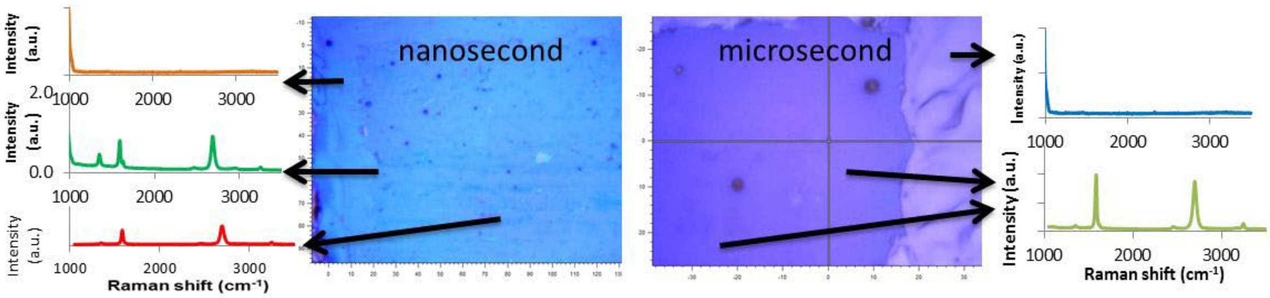

Fig. 2: Optical micrographs of the laser-scribed lines (nanosecond and microsecond) on Si/SiO_2/graphene samples showing the Raman spectra of the different sections.

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