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Reduction Kinetics of Thermally Reduced Graphene Oxide Thin Films

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Fitrilawati, Norman Syakir**,** Annisa Aprilia**,** Zhouyang Liu, Xinliang Feng and Christoph Bubeck

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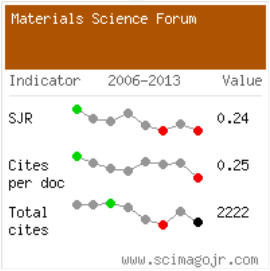

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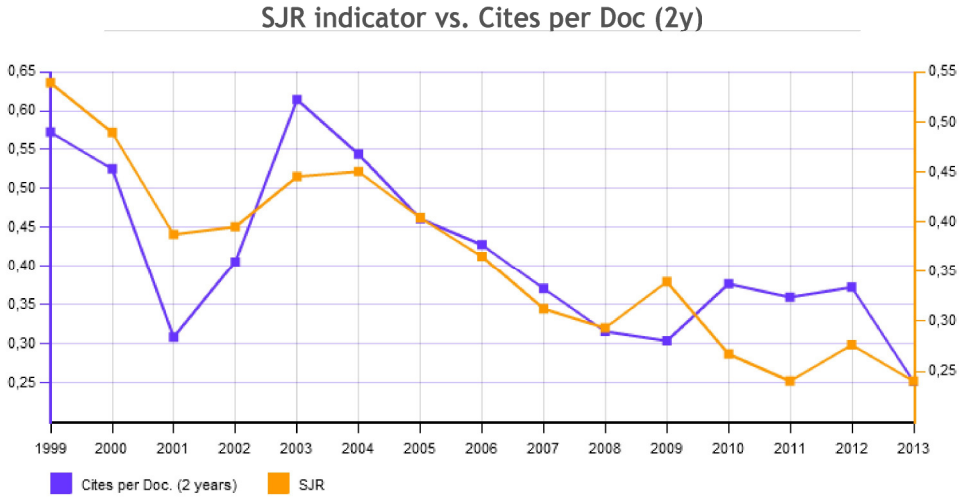

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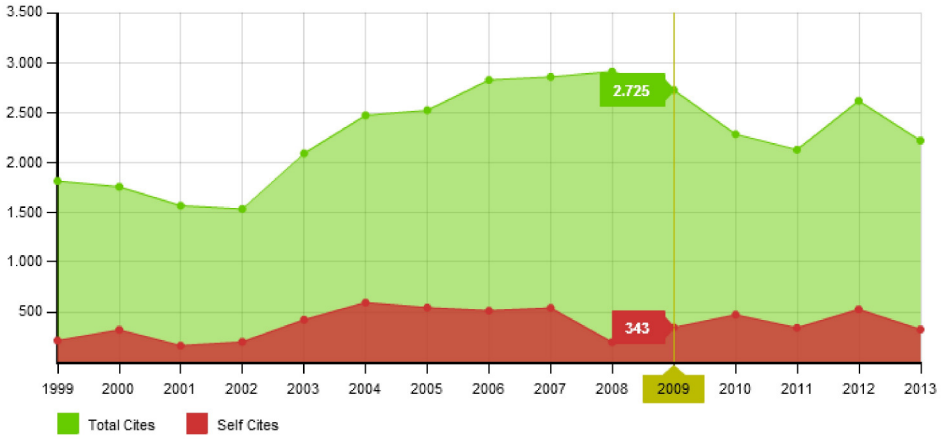

Evolution of the total number of citations and journal's self-citations received by a journal's published documents during the three previous years.

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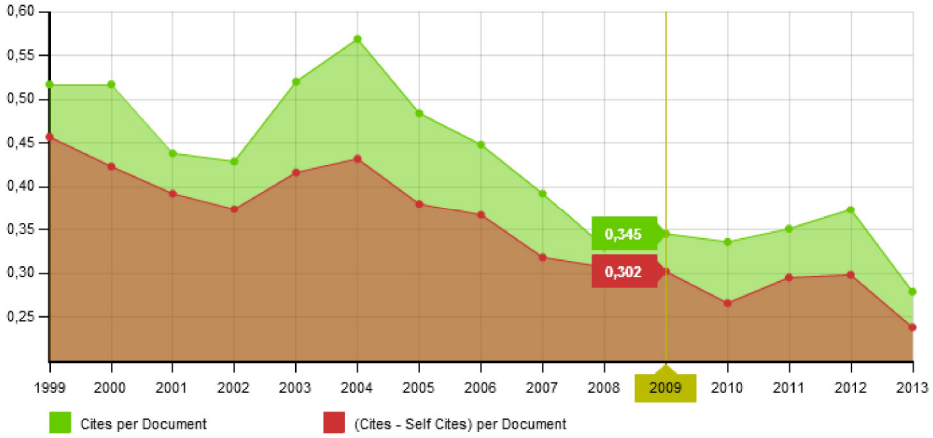

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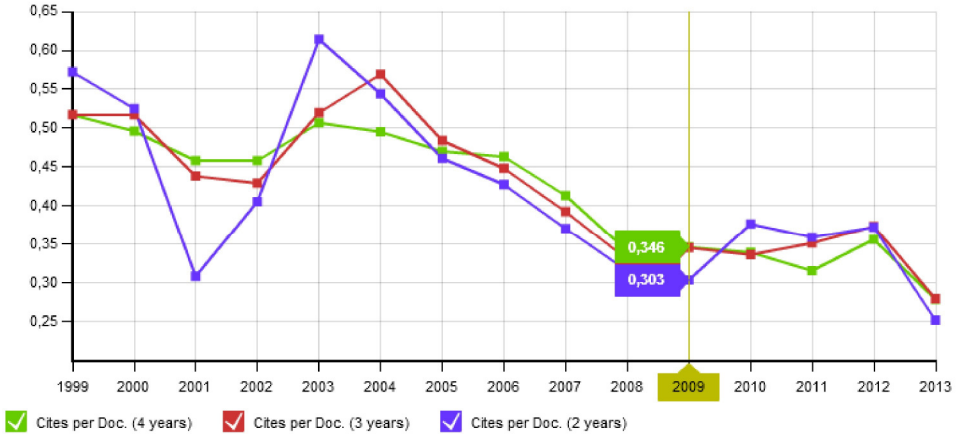
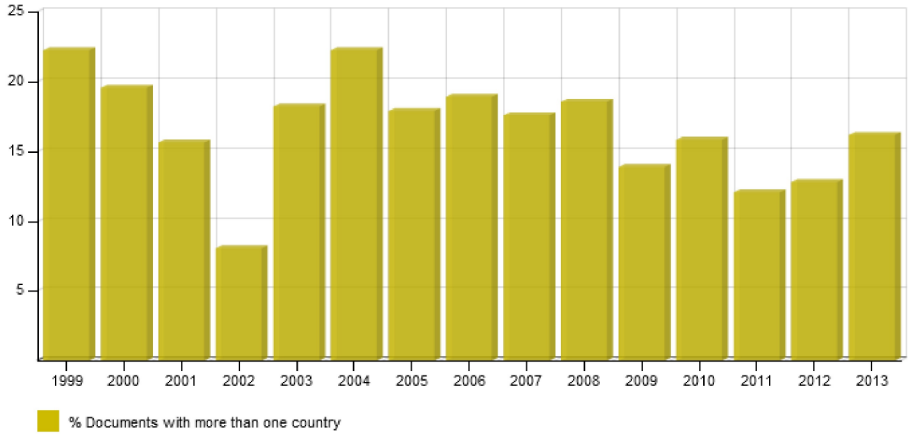
Cites per Document in 2, 3 and 4 years windows



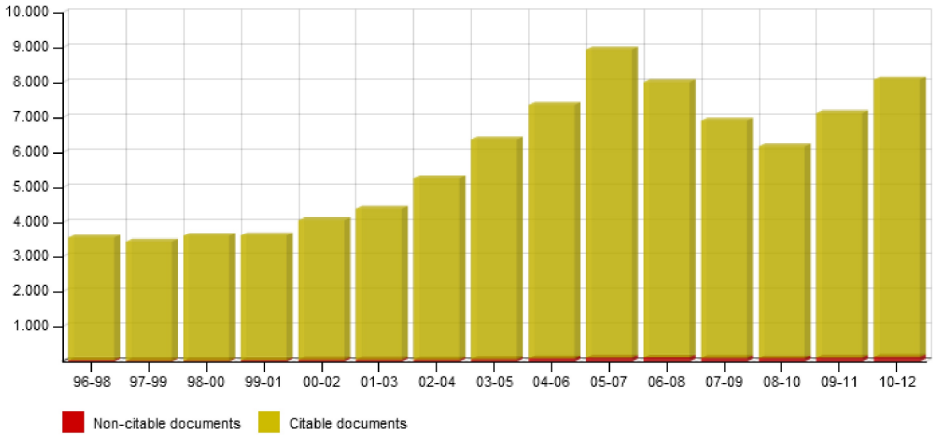
Evolution of Citations per Document to a journal's published documents during the two, three and four previous years. The two years line is equivalent to journal impact factor ™ (Thomson Reuters) metric.

International Collaboration

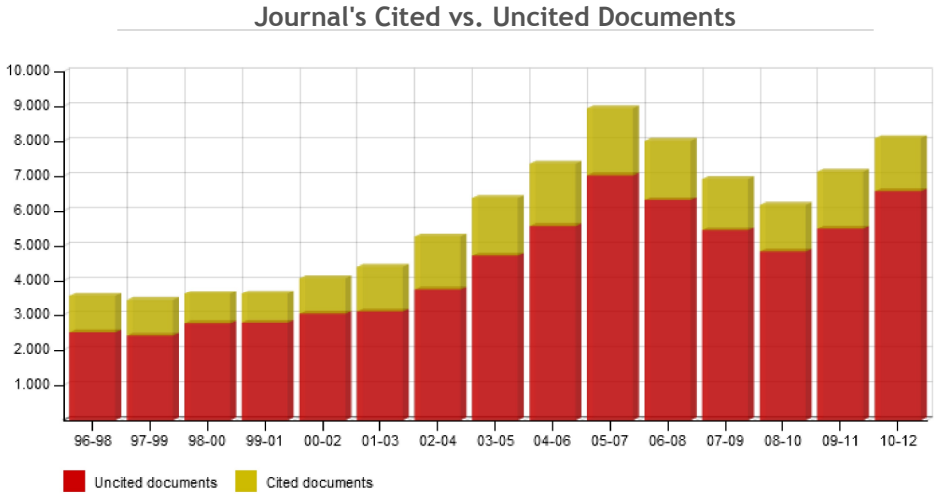


International Collaboration accounts for the articles that have been produced by researchers from several countries. The chart shows the ratio of a journal's documents signed by researchers from more than one country.

Journal's Citable vs. Non Citable Documents



Not every article in a journal is considered primary research and therefore "citable", this chart shows the ratio of a journal's articles including substantial research (research articles, conference papers and reviews) in three year windows.



Ratio of a journal's items, grouped in three years windows, that have been cited at least once vs. those not cited during the following year.

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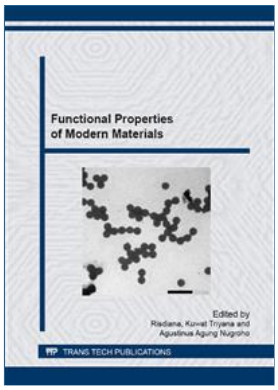

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Reduction Kinetics of Thermally Reduced Graphene Oxide Thin Films

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Keywords: graphene oxide, reduced graphene oxide, thermal reduction, spin coating.

Abstract. We report an experimental study of thermal reduction of graphene oxide (GO) under nitrogen flow. Ultrathin films of GO were prepared on quartz glass substrates by spin-coating from 3 mg/ml aqueous solutions of GO. These films were annealed at 50 °C under vacuum overnight before thermal reduction. The films were exposed to temperatures of 100 °C, 150 °C, 200 °C, 300 °C, 400 °C, 500 °C and 800 °C under nitrogen flowing. We used UV-Vis absorption spectroscopy to monitor the change of absorption spectra caused by thermal reduction. We observed a significant change of absorption spectra due to formation of reduced graphene oxide (RGO). We found that thermal reduction started already at 100 °C, but proceeded significantly faster at heating temperatures higher than 200 °C.

Introduction

Graphene is attracting a lot of attention due to its promising properties for electronic devices [1]. There are several methods in preparing graphene, such as micromechanical exfoliation [1], chemical vapor deposition (CVD) [2], epitaxial growth [3], and the reduction of graphene oxide (GO) [4,5]. Amongst the methods, the reduction of GO is a low-cost approach to prepare graphene-based materials in a large scale, since GO is commercially available.

Single sheets of graphene oxide are prepared by oxidation of graphite in the presence of strong acids and oxidants, followed by a subsequent exfoliation of GO sheets under ultrasonication treatment. An illustration of GO structure is shown in Fig. 1. The GO sheets are decorated with oxygen-containing functional groups such as carboxylic, hydroxylic and epoxidic groups. The GO contains both sp^{2-} and sp^{3-} hybridized carbon atoms. Therefore, GO is nearly electrically insulating. Thermal reduction can remove the oxygen-containing groups from GO and can heal the defects of the conjugated π-electron system of GO. A schematic view of the conversion of GO to RGO is shown in Fig. 1, which illustrates the recovery of sp^2-binding sites in RGO. The restoration of sp^{2-} carbon sites and the recovery of the conjugated π-electron system is indicated by the strongly increasing UV-Vis absorption spectra of RGO.

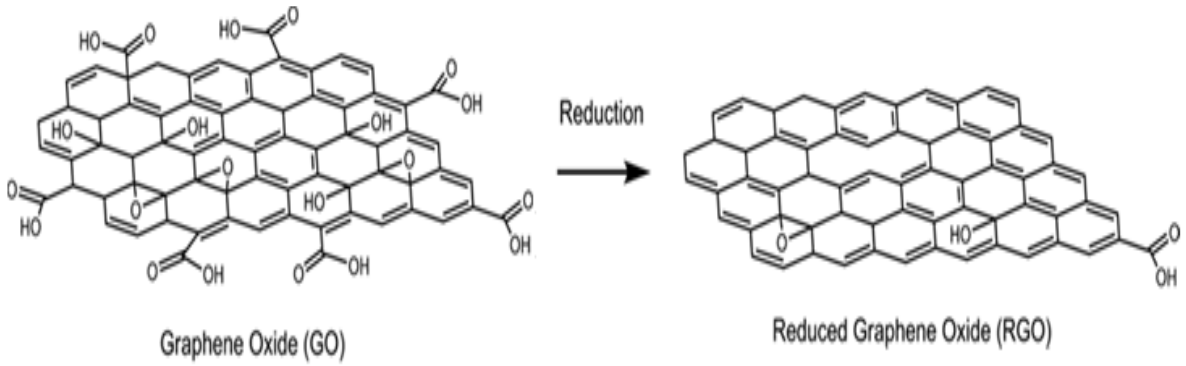

Figure 1. Schematic structures of graphene oxide (GO) and reduced graphene oxide (RGO) [5].