**Supplementary Information for**

**Thermal Reduction of Graphene Oxide: How Temperature Influences Purity**

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**Thermal Degradation Kinetics of GO and rGO**

In this section detailed analysis of thermal degradation kinetics of GO and rGO have been performed by the Coates-Redfern method. The analysis for GO reveals the kinetics of thermal reduction of GO.

In the reaction aA (s) 🡪 bB (g) + cC (g), the rate of reaction of A can be expressed in terms of fractional decomposition rate α as:

 (1)

where *k* is termed as rate constant, *n* is order of reaction and *α* is defined as:

 (2)

where *w0* is initial weight of the specimen, *wt* is weight of specimen at any instant and *w∞* is final weight of the specimen.

Rate constant *k* can be defined as:

 (3)

Where *A* is frequency factor and *Ea* is activation energy and *T* is temperature in Kelvin.

Linear heating rate *β* (in oC/min) can be defined as:

 (4)

According to Coates – Redfern method of analysis, by combining equation (1), (3) and (4) and integrating the following expression is obtained:



Taking logarithm on both sides of the above equation:

 (5)

Equation (5) is valid for reaction of any order except *n*=1. For *n*=1 following equation has been derived:

 (6)

In Coates – Redfern analysis 34 the term  is assumed to be 1 35. Hence, equations (5) and (6) reduce to:

 , for *n*≠1 (7)

and

, for *n*=1 (8)

In equations (7) and (8) left-hand side of the equation is termed as Y and fitted as a straight line against for different values of *n*. Reaction order *n* is chosen from the best fitted straight line. From the slope of the straight line activation energy *Ea* is determined and from intercept, frequency factor can be determined.

|  |  |
| --- | --- |
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| (a) | (b) |

**FIG. S1: Thermal degradation kinetics analysis of (a) GO, (b) rGO reduced at 350oC**

Analysis of thermal degradation kinetics reveals that best fit of the data is obtained for n=0 (FIG. S1(a)), i.e. thermal reduction of GO follows zero order kinetics. The rate of thermal reduction of GO is a function of temperature only. This supports the findings of thermogravimetric analysis (TGA) that reduction of GO takes place beyond a particular temperature.

From the analysis of thermal degradation kinetics of rGO (annealing temperature 350oC) order of reaction has been determined to be 0.1, i.e. rate of reaction is dependent on the concentration of rGO. Thermal degradation of rGO involves mainly combustion of carbon skeleton and elimination of remaining functional groups. Therefore, the rate of reaction is dependent on the amount of rGO, unlike GO. Evaluated values of frequency factor and activation energy for the reaction are reported in TABLE SI.

**TABLE SI: Kinetic parameters of GO and rGO determined by the Coates-Redfern method**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Component** | **Slope** | **Intercept** | **Activation Energy (kJ/mole)** | **Frequency Factor** | **Reaction Order** |  |
| ***E/R=m*** | ***C*** | ***Ea*** | ***A*** | ***n*** | ***R2*** |
| GO | 2238.83 | -7.705 | 18.61 | 10.085 | 0 | 0.93458 |
| rGO | 931.59 | -12.672 | 7745.27 | 0.0292 | 0.1 | 0.98242 |