Thermally reduced graphene oxide (TRGO): study of thermal defunctionalization

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Results

The thermal stability and the kinetics of thermal decomposition of the thermally reduced graphene oxide (TRGO) have been studied. Modified Hummers method was used for obtaining the initial graphite oxide (GO) from graphite powders. The thermal exfoliation of the graphene oxide powder has been performed in the vacuum conditions when heated with the temperature rate of 5–7 K/min to a temperature of 300°C for obtain the TRGO. The samples of TRGO were treated by a pulsed high-frequency discharge in a hydrogen atmosphere before measurements.Pulsed high-frequency discharge in a hydrogen atmosphere of TRGO lead for partial graphene hydrogenation (chemical addition of atomic hydrogen) that leads to structural changes in the carbon planes and the formation of C-H sp^3 bonds. The TGA measurements have been carried from room to 1000°C in a nitrogen atmosphere with a nitrogen flow and different heating rate by using Perkin-Elmer (PE-TGA4000).

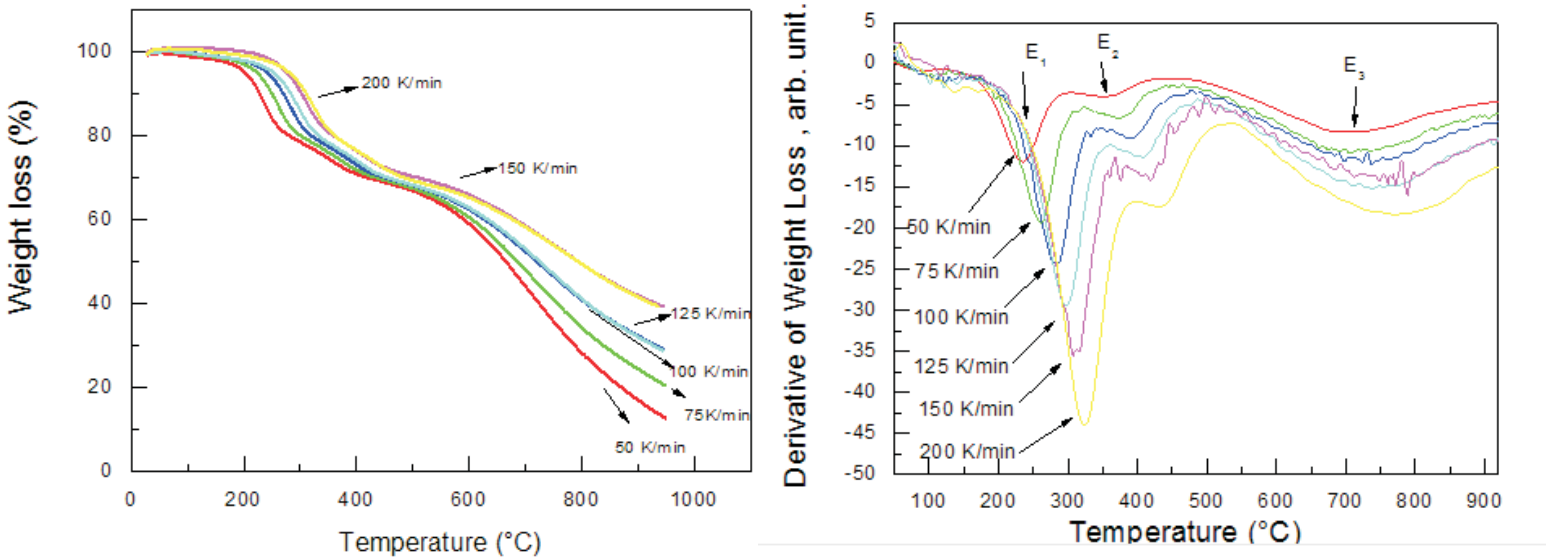
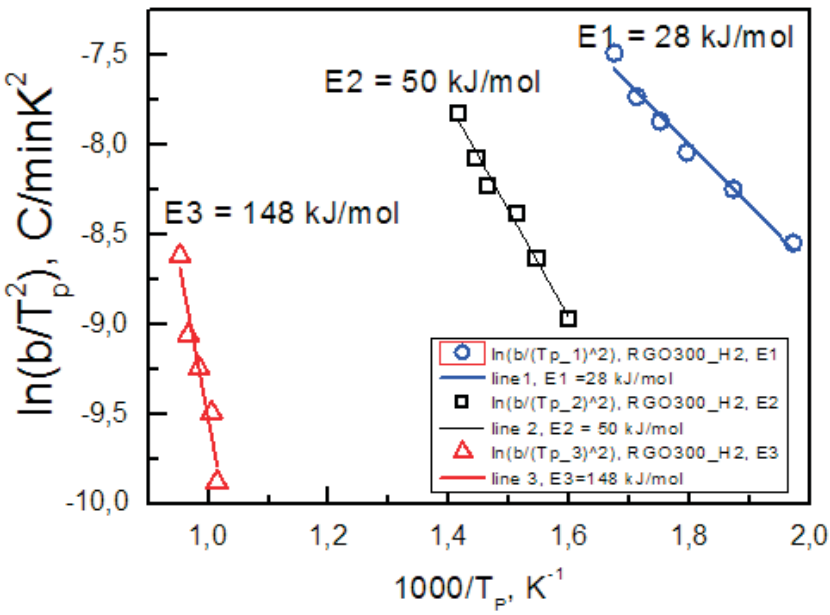


Fig. 1. Variation in the weight loss (%) and DTG curve vs. T for thermally reduced graphene oxide TRGO for heating rate 50K/min (red curve), 75 K/min (green), 100 K/min(blue), 125 K/min (aquamarine) ,150 K/min (pink) and 200 K/min (yellow).



Activation energy calculated from the equation(Kissenger's method (KM)):

- β - the heating rate,
- Tp - temperature of the peak on the DTG
- Ea - activation energy,
- A is the Arrhenius factor

$$\ln\left(\frac{\beta}{T_P^2}\right) = \ln\left(\frac{E_a}{R}\right) - \ln A + \frac{E_a}{RT_p}$$

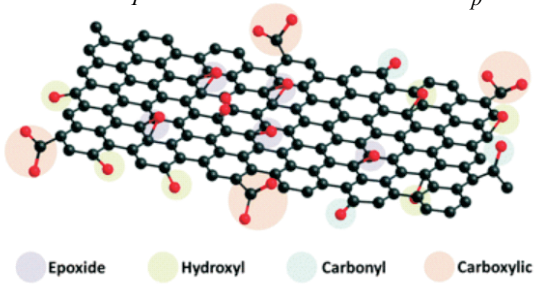


Fig. 2. Kissinger plot from the experimental data at heating rates 50 K/min, 75 K/min, 100 K/min, 125 K/min, 150 K/min, and 200 K/min for three kinetic processes in the TRGO

Conclusion:

Thermal decomposition of oxygen-containing functional groups on the surface of thermally reduced in hydrogen atmosphere graphene oxide (TRGO) was studied. E3 =148 kJ/mol is close to that of the thermal decomposition of anhydride functional groups in MWCNT. E2 =50 kJ/mol is apparently indicated the presence of the ketoand hydroxy acids function groups on TRGO. E1 =28 kJ/mol related with all other groups including the lighters C-H bonds.