Controlled *in-situ* reduction of graphene oxide thin films via thermal annealing and e-beam irradiation

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Mass production of graphene based devices and hybrid materials from graphene oxide requires reduction process to change its structure from highly oxygen group decorated graphene sheet to pure hexagonally arranged carbon sheets. Possible reduction routes are chemical reduction, temperature annealing, UV or electron beam irradiation[1]. The important issue is to know how these processes change GO properties during and after reduction process.

We report, research on reduction process of GO thin films controlled by *in-situ* 4-probe electrical measurements using two reduction approach. First, thermal reduction of graphene oxide thin films in temperature range of (450 K – 500 K) in normal atmosphere. We demonstrate that in every annealing temperature rGO reaches its stationary state (Figure 1). Additionally, the discussion on thermal - reduction kinetics [2,3] will be presented.

Second, electron beam reduction process is employed to find an influence of electron beam irradiation on electrical transport in graphene oxide thin films during transition from insulation to conduction state(Figure 2).

Monitoring of these two reduction processes allow us to control reduction level of rGO thin films which is important in further production of graphene based devices.

References

[1] S. Pei et. al., Carbon, 50 (2012);
[2] I. Jung et. al., J. Phys. Chem., 113(2009);
[3] Y. Qiu et. al., Carbon, 96 (2016);

Figures

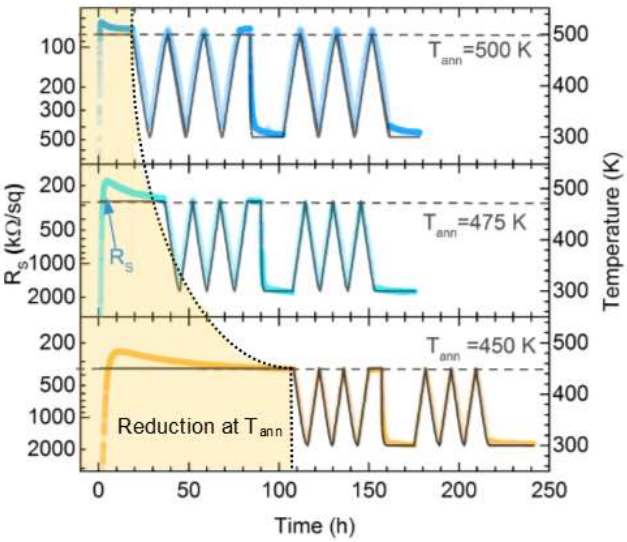

Figure 1: *In-situ* measurements results obtained for three annealing temperatures of thin film GO samples. The yellow shaded area represent reduction part with dotted line as a guide for eye.

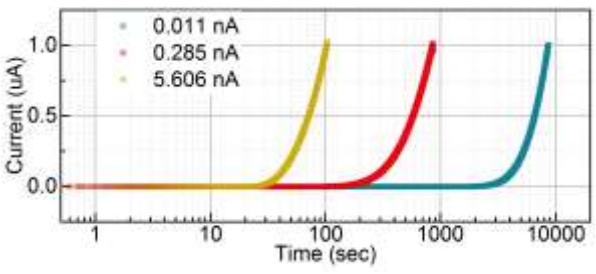

Figure 2: *In-situ* The current changes of three GO devices irradiated with different electron beam currents.