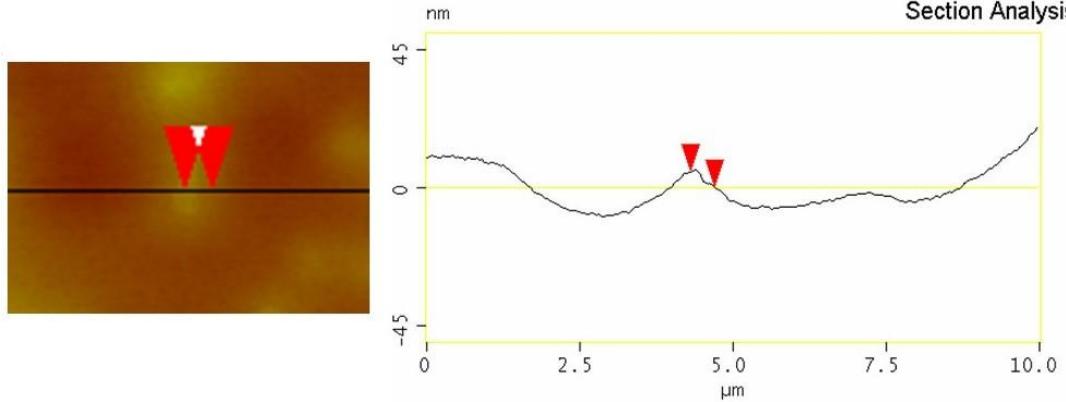**Figure S1.** AFM images of reduced graphene oxide films**.**

Figure S2. Image of conductivity testing of rGO film using a four probe tester

Figure S3. Image of conductivity testing of PHrGO film using a four probe tester

Figure S4. Optical photograph of a multi-function digital four probe tester.

Table S1. Parameters of Multi-function Digital Four Probe Tester

items	parametric
Square Resistance Range	$10^{-5}\sim2\times10^5$ Ω/sq
Resistivity range	$10^{-5}\sim2\times10^6$ Ω·cm
Test current range	0.1μA，1μA，10μA，100μA，1mA，10mA，100 mA
Current Accuracy	± 0.1%
Resistance Accuracy	≤ 0.3%
Display readout LCD	Resistance, resistivity, square resistance, temperature, unit conversion, temperature coefficient, current, voltage, probe shape, probe spacing, thickness, conductivity
Test Method	bielectricity measurement
Operating power	Input: AC 220V±10%，50Hz Power Consumption：<30W
Uncertainty error of the whole machine	≤4%（Standard Sample Results）
Test Probes	Probe spacing： 2.35mm;