Supporting Information

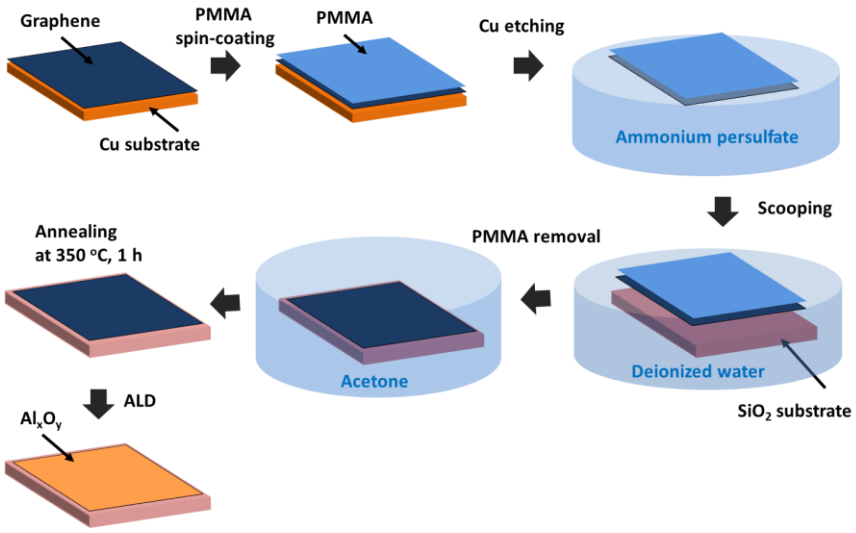

Figure S1. The protocol to transfer CVD-graphene grown on Cu foil onto SiO_2 substrate with pre-annealing prior to ALD treatment (See Methods).

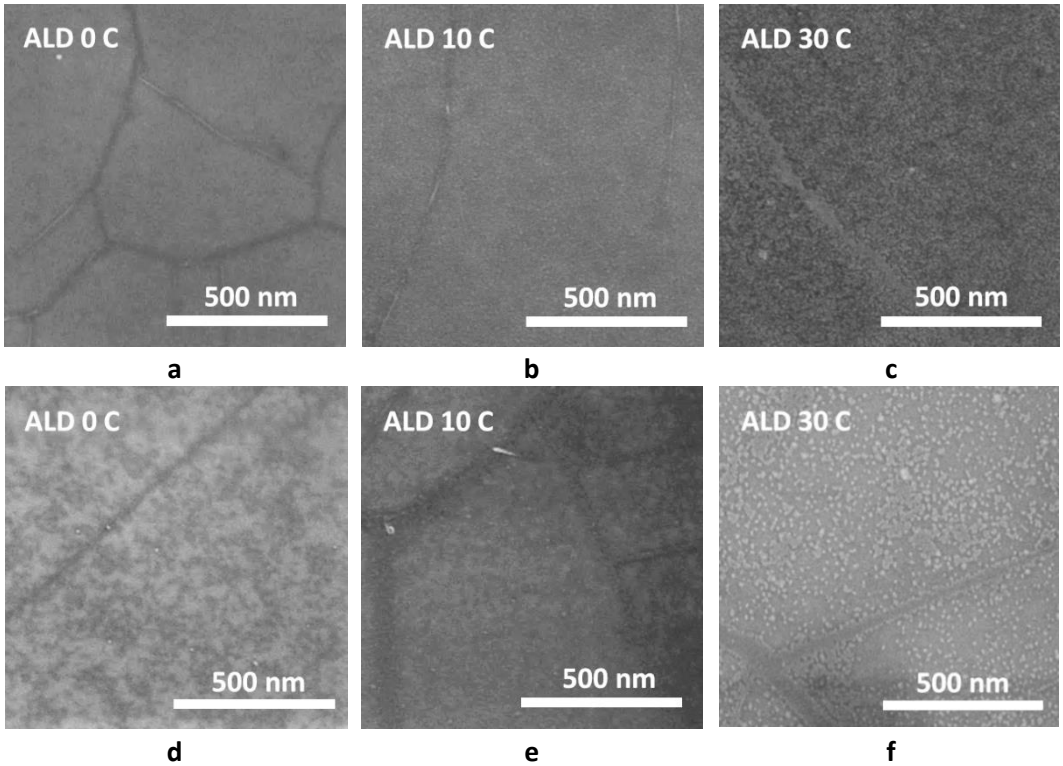

Figure S2. First row (**a-c**) and second row (**d-f**) show SEM images of raw and pre-annealed CVD-graphene after treatment of 0, 10, and 30 cycles of Al_2O_3 ALD, respectively.

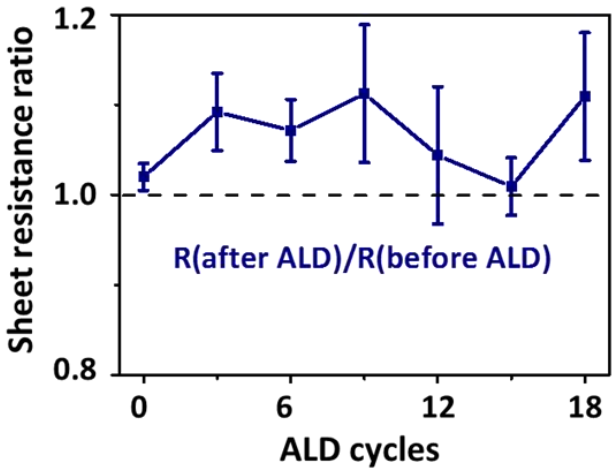

Figure S3. Variation in electrical sheet resistances of the non-annealed CVD-graphene before and after treating with different cycles of Al_2O_3 ALD.

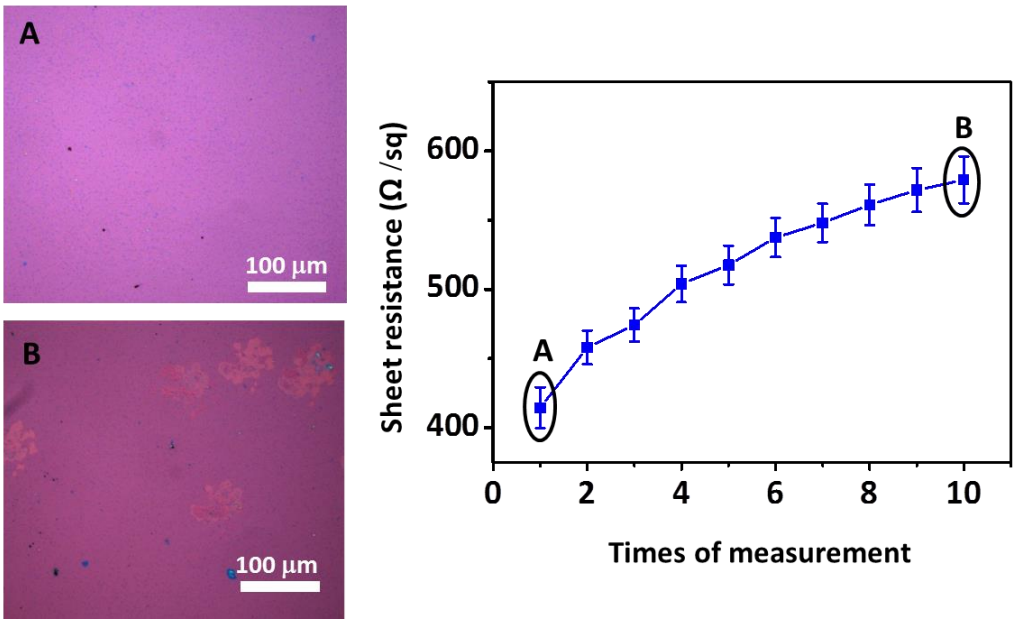

Figure S4. Damages in the graphenes caused by probes used for electrical sheet resistance measurements. As can be recognized from optical microscope images and plot of sheet resistance, the repetitive four probes measurements accelerate the damages in the graphene and thus increase in sheet resistance.

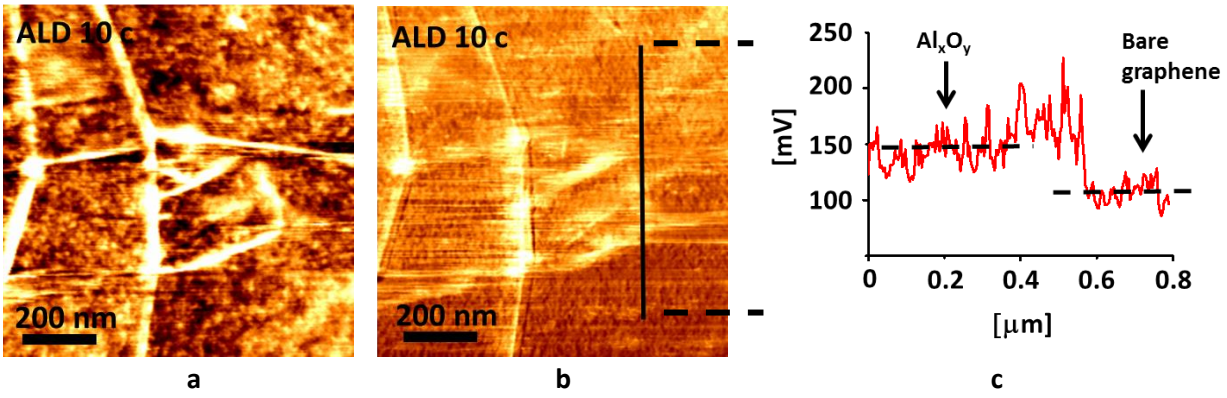

Figure S5. AFM images of the graphene treated with 10 ALD cycles. **a,** The topographic image **b,** The corresponding lateral force image **c,** The voltage profile of the vertical line in **b.** Region of bare graphene exhibits lower friction force than the deposited area and wrinkles.

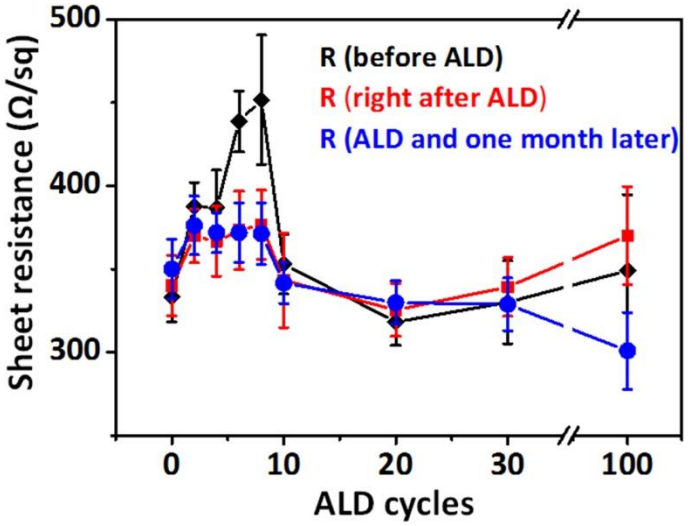

Figure S6. Reduction of sheet resistance in graphenes by ALD treatment and long term stability of ALD treated graphenes. For these measurements, numerous representative graphene samples were prepared and firstly sheet resistances were measured (black symbols). Subsequently, those samples were treated with ALD and the sheet resistances were immediately measured (red symbols). One month later, the sheet resistances of the identical samples were once more measured (blue symbols) and compared.

Table S1. Comparison of sheet resistances between the non-annealed and the annealed graphenes without ALD treatments. Representative samples were randomly chosen. Most of the graphene samples showed nearly the same trends.

Sample #	A. Non-annealed [Ω/sq]	B. Annealed [Ω/sq]	Ratio [B/A]
1	375 ± 20	326 ± 35	0.86
2	471 ± 11	425 ± 20	0.90
3	559 ± 17	489 ± 35	0.87