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A new strategy for efficient exfoliation of graphite into graphene

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1 Figures

Fig. S1 TEM images of obtained graphene with grinding treatment after ultrasonication. Experimental conditions: graphite, 0.5 g; NMP for ultrasonication, 50 mL; NMP for grinding, 5 mL;

ultrasonication time, 30 min; grinding, 1 h; centrifugation at 600 rpm for 90 min.

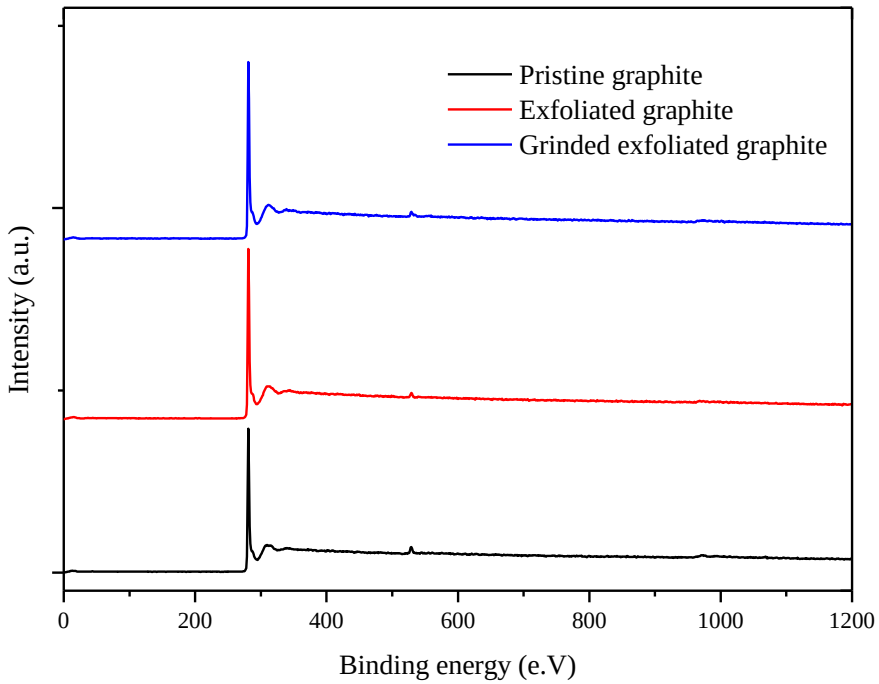

Fig. S2 XPS spectra of graphite before and after grinding treatment. Experimental conditions: graphite, 0.5 g; NMP for ultrasonication, 50 mL; NMP for grinding, 5 mL; ultrasonication time, 30 min; grinding, 1 h; centrifugation at 600 rpm for 90 min.

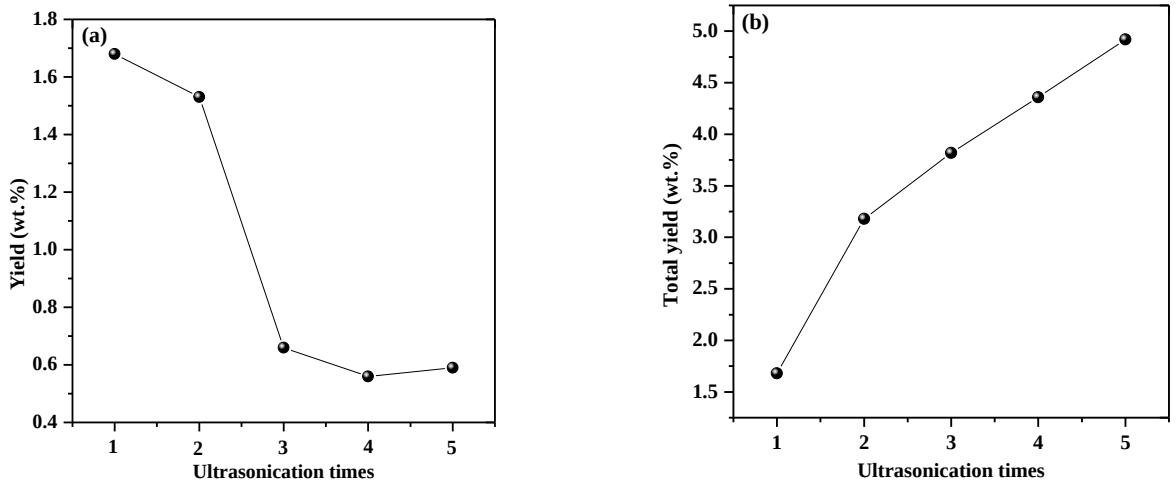

Fig. S3 (a) The effect of ultrasonication times on the yield of graphene; (b) the effect of ultrasonication times on the total yield of graphene. Experimental conditions: pristine graphite (0.5 g) in NMP (50 mL) was treated by the 1st ultrasonication (30 min), after ultrasonication, the mixture was sent to centrifuge at 600 rpm for 90 min to obtained the graphene suspension, and the residual exfoliated graphite was directly resent to the next time of ultrasonication. The 2nd, 3rd, 4th and 5th ultrasonication were treated as the same conditions.

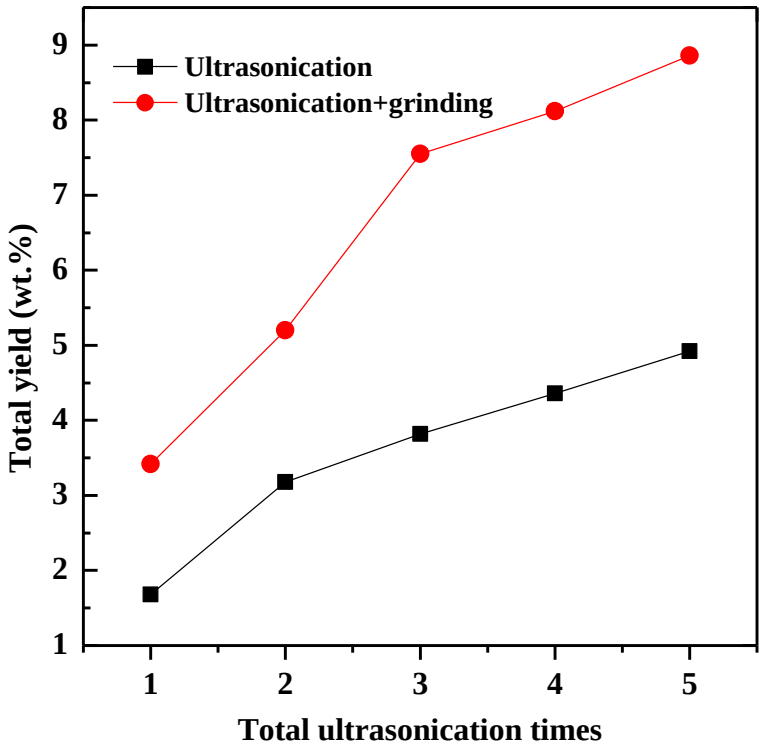

Fig.S4 The yield comparison between the graphene obtained by ultrasonication and ultrasonication+grinding treatment with the same total ultrasonication times. For total ultrasonication times as 1: the black square represented that the yield of graphene was obtained by pristine graphite in NMP for the 1st ultrasonication; the red circle represented the yield of graphene was obtained that the pristine graphite was grinded for 1 h and then collected to the 1st ultrasonication. For the total ultrasonication times as 2: the black square represented the yield of graphene obtained by the ultrasonication of the exfoliated graphite after 1st ultrasonication; the red circle represented the yield of graphene obtained by the grinding followed by ultrasonication treatment of exfoliated graphite after the 1st ultrasonication. For the total ultrasonication times as 3: the black square represented the yield of graphene obtained by the ultrasonication of the exfoliated graphite after 2nd ultrasonication; the red circle represented the yield of graphene obtained by the grinding followed by ultrasonication treatment of exfoliated graphite after the 2nd ultrasonication. For the total ultrasonication times as 4: the black square represented the yield of graphene obtained by the ultrasonication of the exfoliated graphite after 3rd ultrasonication; the red circle represented the yield of graphene obtained by the grinding followed by ultrasonication treatment of exfoliated graphite after the 3rd ultrasonication. For the total ultrasonication times as 5: the black square represented the yield of graphene obtained by the ultrasonication of the exfoliated graphite after 4th ultrasonication; the red circle represented the yield of graphene obtained by the grinding followed by ultrasonication treatment of exfoliated graphite after the 4th ultrasonication. Experimental conditions: pristine graphite (0.5 g) in NMP (50 mL) was treated by the 1st ultrasonication (30 min), after ultrasonication, the mixture was sent to centrifuge at 600 rpm for 90 min to obtained the graphene suspension, and the residual exfoliated graphite was directly resent to the next time of ultrasonication or grinding for 1 h. The volume of NMP for grinding treatment was 5 mL. The 2nd, 3rd, 4th and 5th ultrasonication were treated as the same centrifugation and ultrasonication conditions.

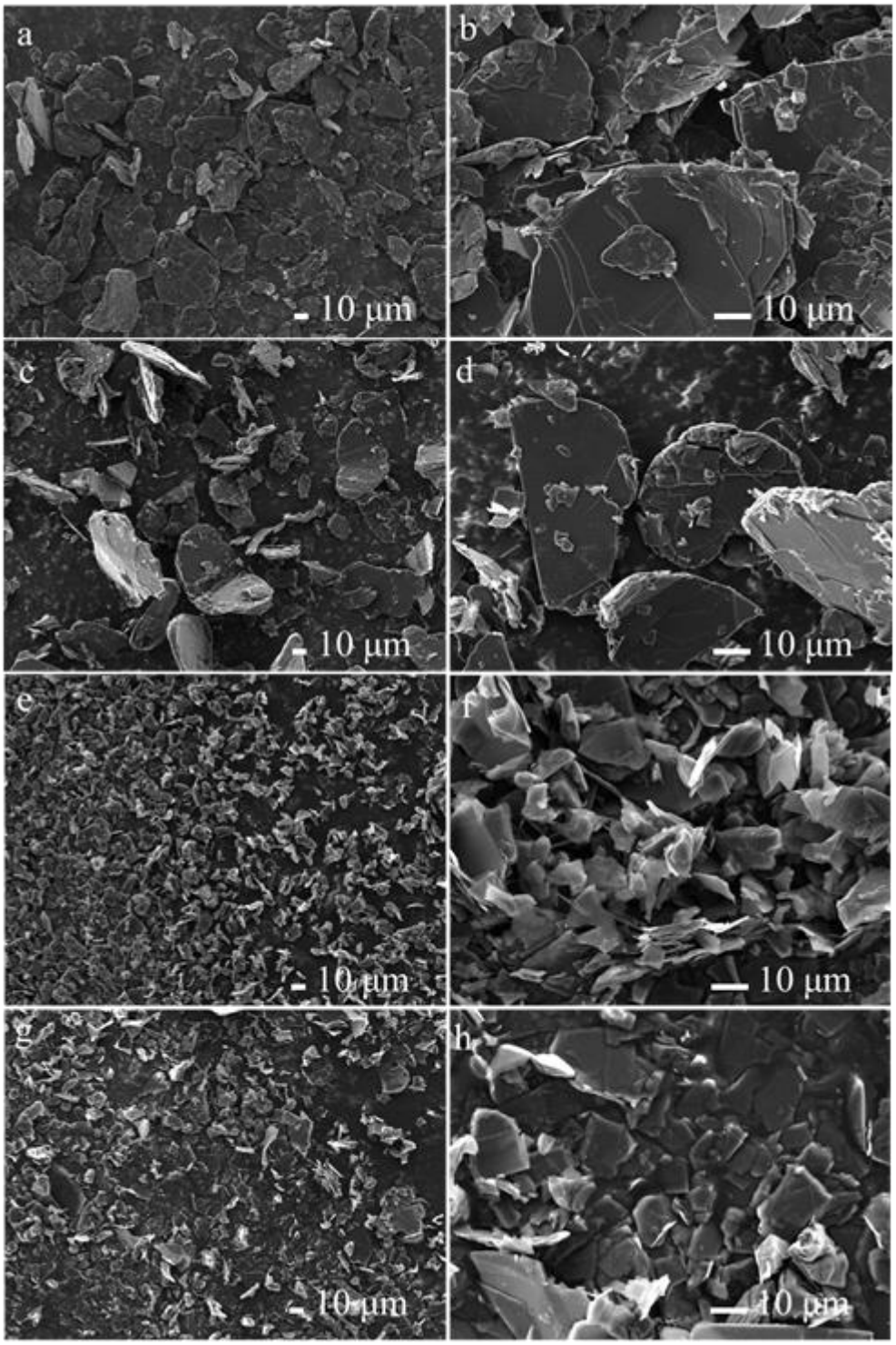

Fig. S5 SEM images of graphite of different particle size before and after ultrasonication. a-b: pristine graphite of 325 mesh; c-d: graphite of 325 mesh after ultrasonication; e-f: pristine graphite of 3000 mesh; g-h: graphite of 3000 mesh after ultrasonication. Experimental conditions: graphite, 0.5 g; NMP for ultrasonication, 50 mL; NMP for grinding, 5 mL; ultrasonication time, 30 min; grinding, 1 h; centrifugation at 600 rpm for 90 min.

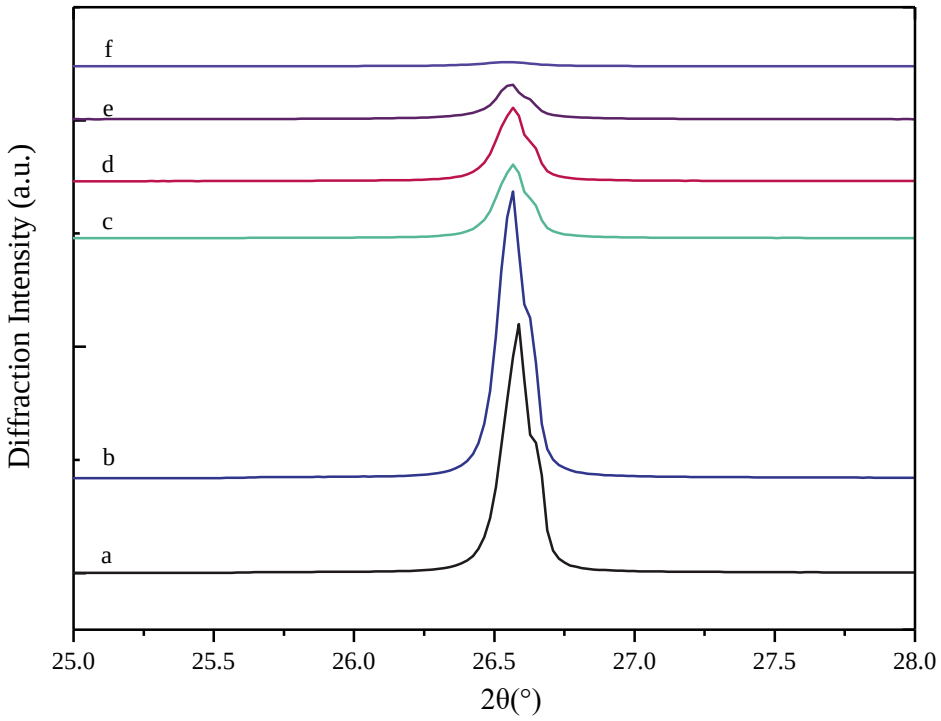

Fig. S6 XRD spectra of graphene powder and graphite of different mesh before and after ultrasonication. a: pristine graphite of 325 mesh; b: after sample a was treated with ultrasonication, the graphene dispersion was centrifuged, then decanted to obtain the exfoliated graphite denoted as b; c: pristine graphite of 3000 mesh; d: after sample c was treated with ultrasonication, the graphene dispersion was centrifuged, and then decanted to obtain the exfoliated graphite denoted as d; e: after sample a was treated with ultrasonication, the graphene dispersion was decanted and collected for extraction filtration, then dried to obtain the graphene powder denoted as e; f: after sample c was treated with ultrasonication, the graphene dispersion was decanted and collected for extraction filtration, then dried to obtain the graphene powder denoted as f. Experimental conditions: graphite, 0.5 g; NMP for ultrasonication, 50 mL; NMP for grinding, 5 mL; ultrasonication time, 30 min; grinding, 1 h; centrifugation at 600 rpm for 90 min.

2 Tables

Table S1 Characteristics of graphene and graphite of different meshes*

Samples	*FWHM* [i]	2*θ*/ ° [ii]	*d*/nm [iii]	*D*/nm [iv]
a	0.12	26.6	0.34	1.72
b	0.15	26.5	0.35	1.72
c	0.14	26.6	0.34	1.72
d	0.12	26.6	0.34	1.38
e	0.14	26.5	0.35	1.38
f	0.12	26.6	0.36	0.86

*a: pristine graphite of 325 mesh; b: after sample a was treated with ultrasonication, the graphene dispersion was centrifuged, then decanted to obtain the exfoliated graphite denoted as b; c: pristine graphite of 3000 mesh; d: after sample c was treated with ultrasonication, the graphene dispersion was centrifuged, and then decanted to obtain the exfoliated graphite denoted as d; e: after sample a was treated with ultrasonication, the graphene dispersion was decanted and collected for extraction filtration, then dried to obtain the graphene powder denoted as e; f: after sample c was treated with ultrasonication, the graphene dispersion was decanted and collected for extraction filtration, then dried to obtain the graphene powder denoted as f. Experimental conditions: graphite, 0.5 g; NMP for ultrasonication, 50 mL; NMP for grinding, 5 mL; ultrasonication time, 30 min; grinding, 1 h; centrifugation at 600 rpm for 90 min.

[i] *FWHM*: full width at a half maximum;

[ii] 2*θ*: typical diffraction angle;

[iii] *d*: the d-spacing between the graphite layers;

[iv] *D*: the vertical distance along the plane of (002) for each sample.