

Fig. S1. Typical Raman spectra of the all studied samples. Samples' synthesis conditions can be found in Table 1.

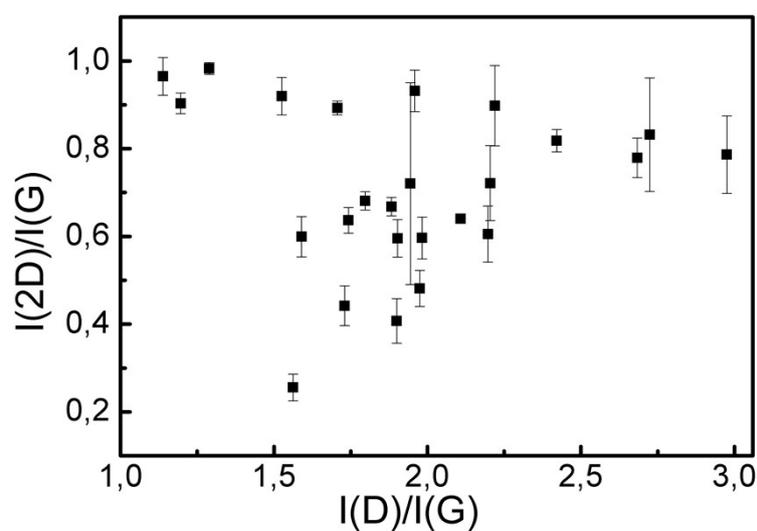


Fig. S2 I(2D)/I(G) ratio vs. I(D)/I(G) ratio.

It can be seen that in most cases I(2D)/I(G) ratio increase with I(D)/I(G) ratio. While increased defects density should decrease I(2D)/I(G) ratio [1]. Thus one can see that we can use I(2D)/I(G) ratio for graphene layer number evaluation.

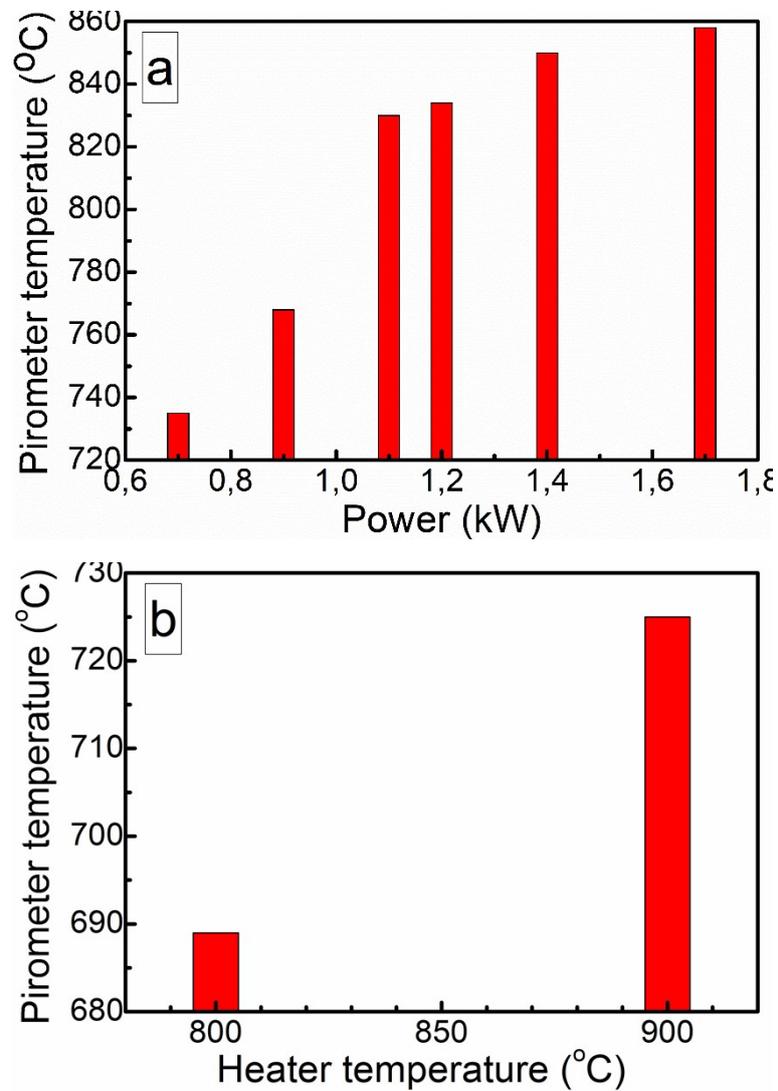


Fig. S3. The dependence of the protective enclosure temperature on plasma power (a), the dependence of the protective enclosure temperature on heater temperature (b).

One can see some enclosure temperature increase with plasma power. However, that increase is the largest when plasma power increases from 0.7 to 1.1 kW. In addition, protective enclosure temperature increases with the heater temperature. However, that increase is much smaller than the heater temperature increase. Thus, sample temperature increase with plasma power is even smaller than one can see in Fig. S2a.

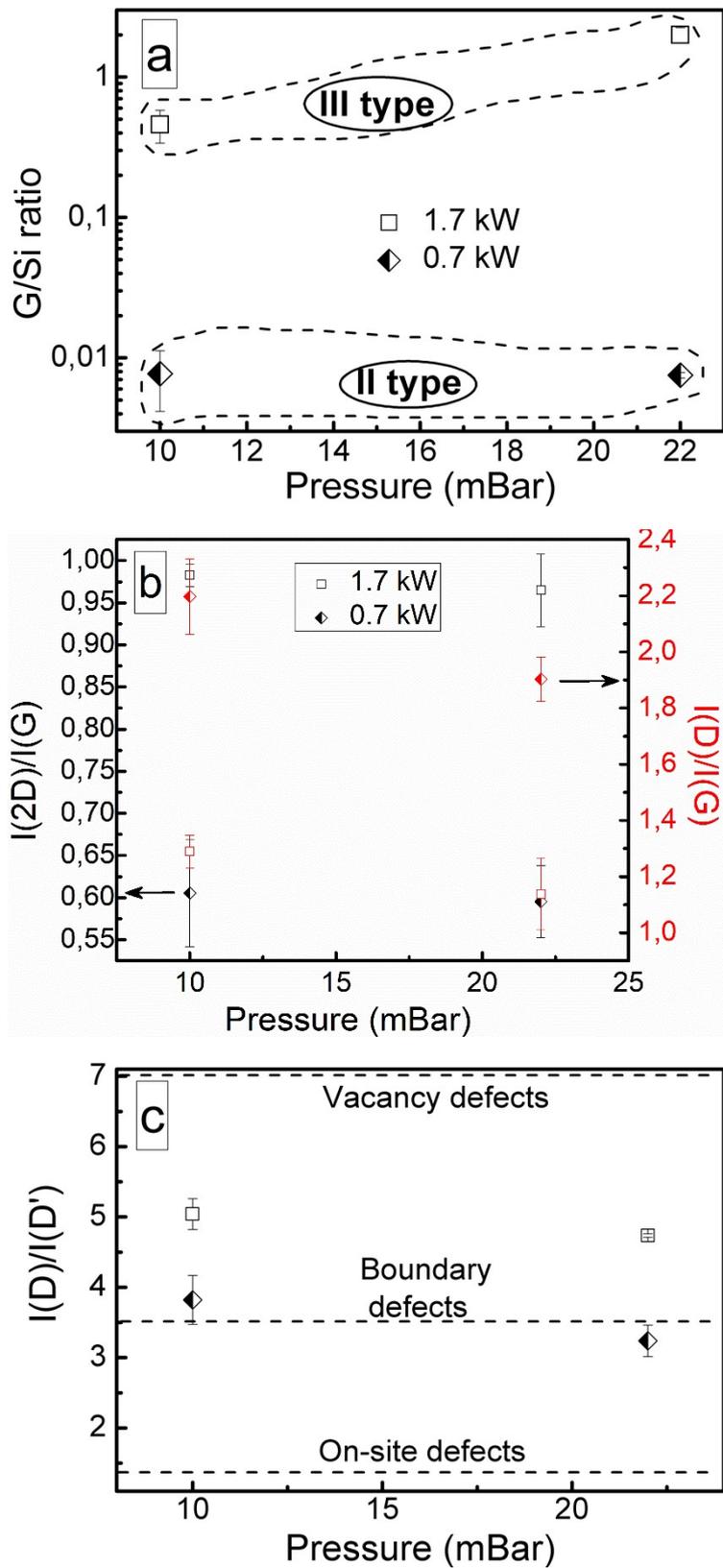


Fig. S4. Pressure effects on the structure of the graphene: $I(2D)/I(G)$ and $I(D)/I(G)$ ratios (a), $I(G)/I(Si)$ ratio (b), $I(D)/I(D')$ ratio (c).

AFM study of the morphology and phase structure

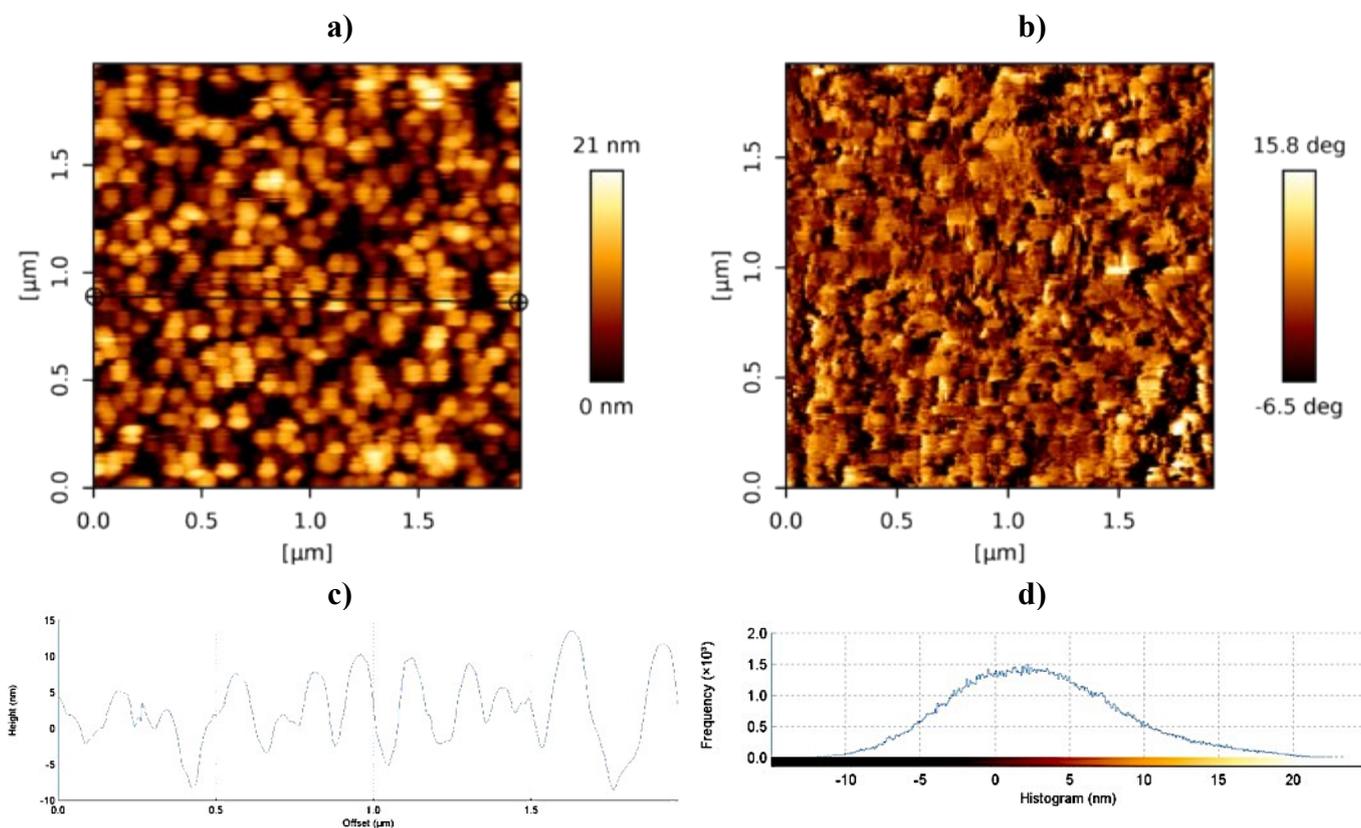


Fig. S5. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 444 (graphene synthesis conditions were: H_2 flow was 150 sccm, CH_4 flow was 50 sccm, power 1.7 kW, time 50 min, pressure 22 mBar, temperature 900 °C).

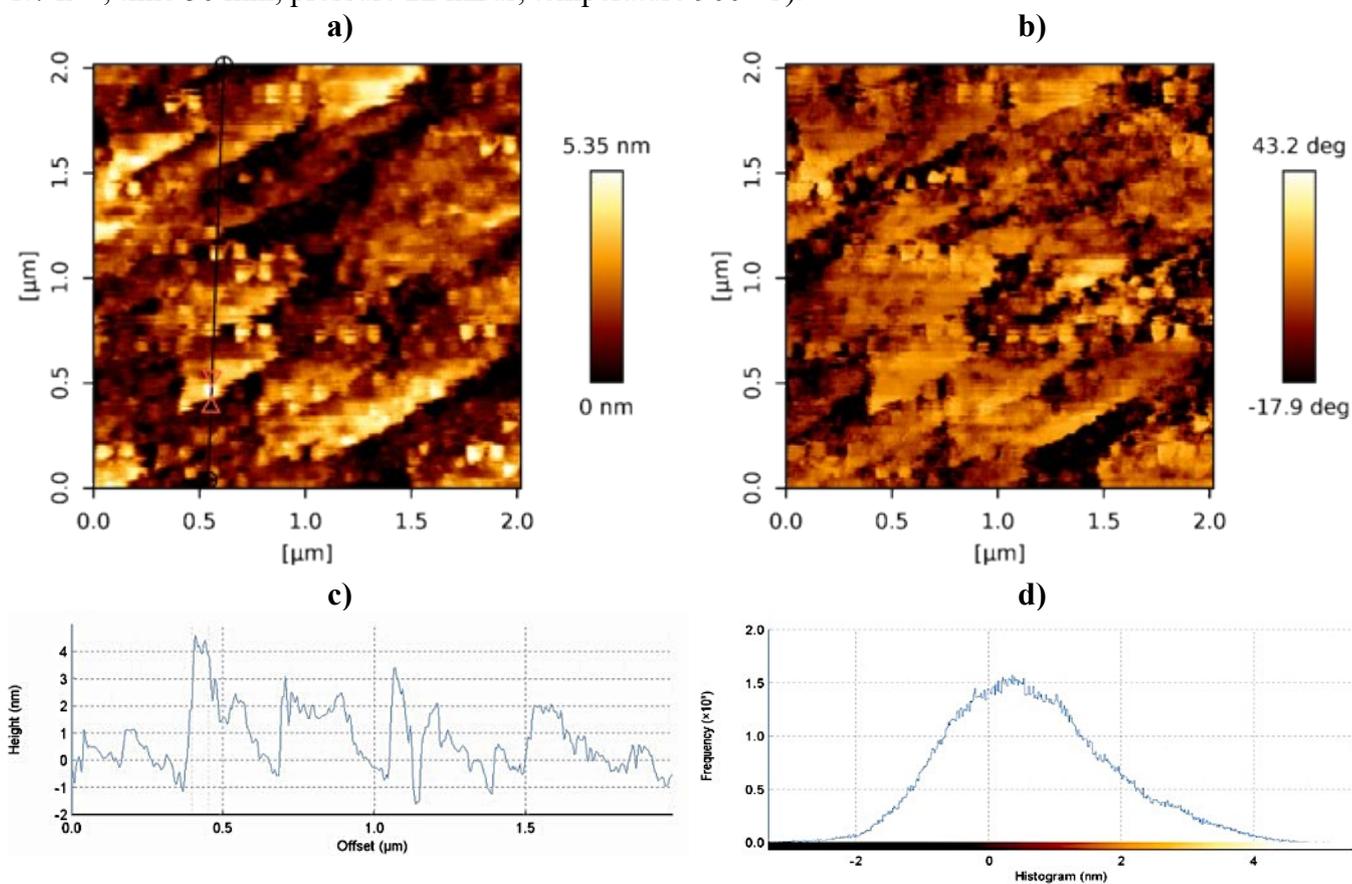


Fig. S6. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 453 (graphene synthesis conditions were: H_2 flow was 150 sccm, CH_4 flow was 50 sccm, power 1.4 kW, time 50 min, pressure 22 mBar, temperature 900 °C).

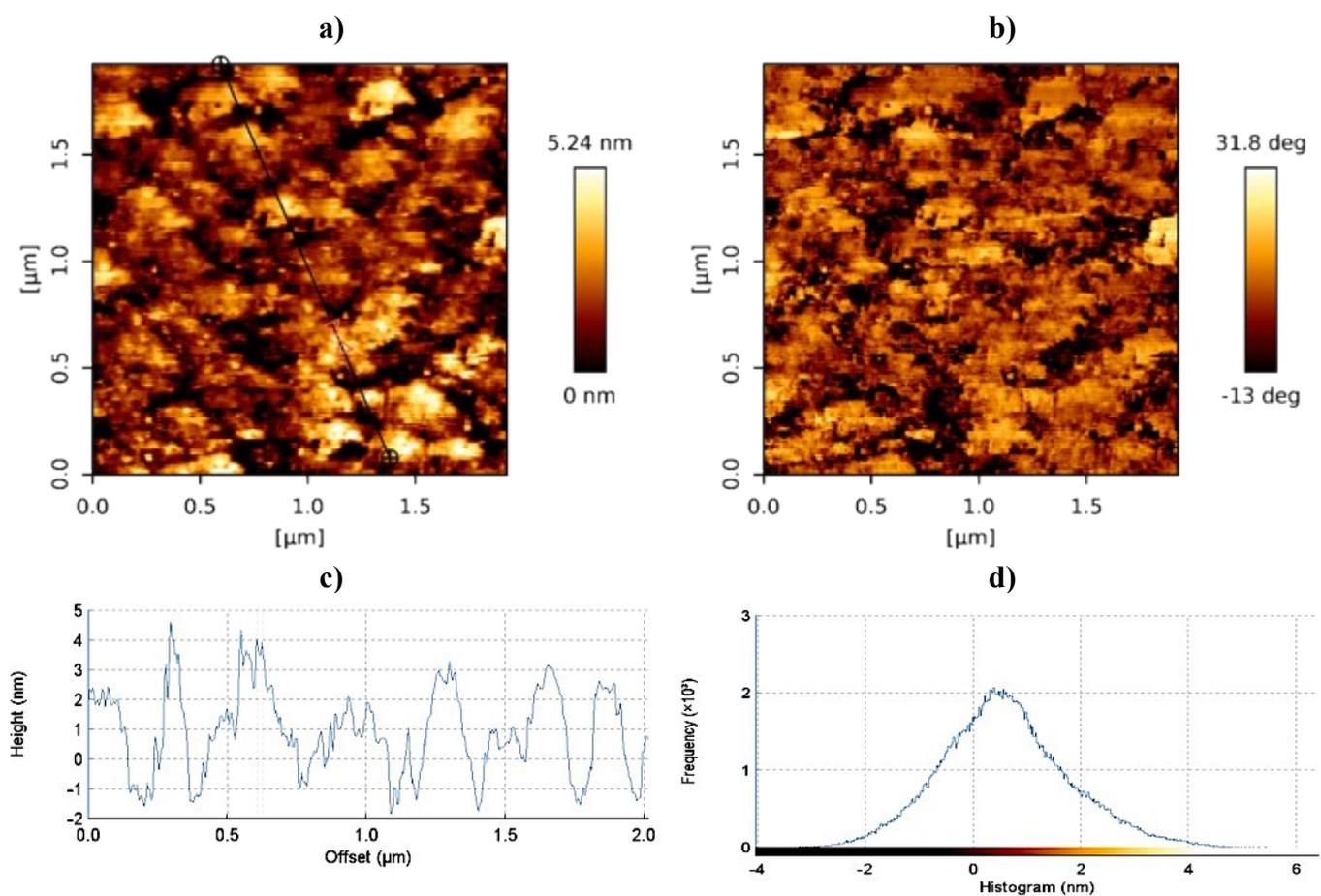


Fig. S7. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 454 (graphene synthesis conditions were: H₂ flow was 150 sccm, CH₄ flow was 50 sccm, power 1.1 kW, time 50 min, pressure 22 mBar, temperature 900 °C).

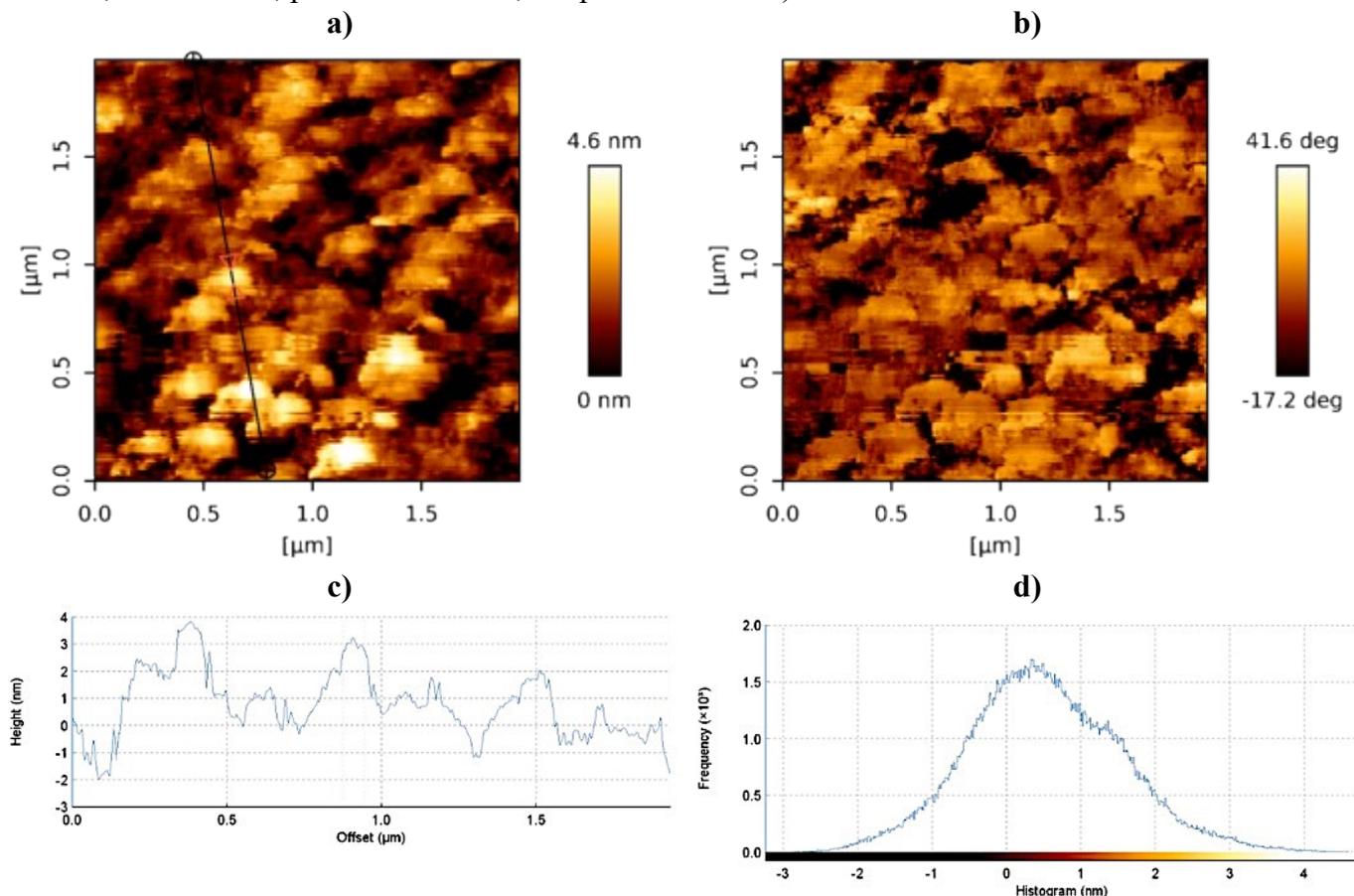


Fig. S8. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 455 (graphene synthesis conditions were: H₂ flow was 150 sccm, CH₄ flow was 50 sccm, power 0.9 kW, time 50 min, pressure 22 mBar, temperature 900 °C).

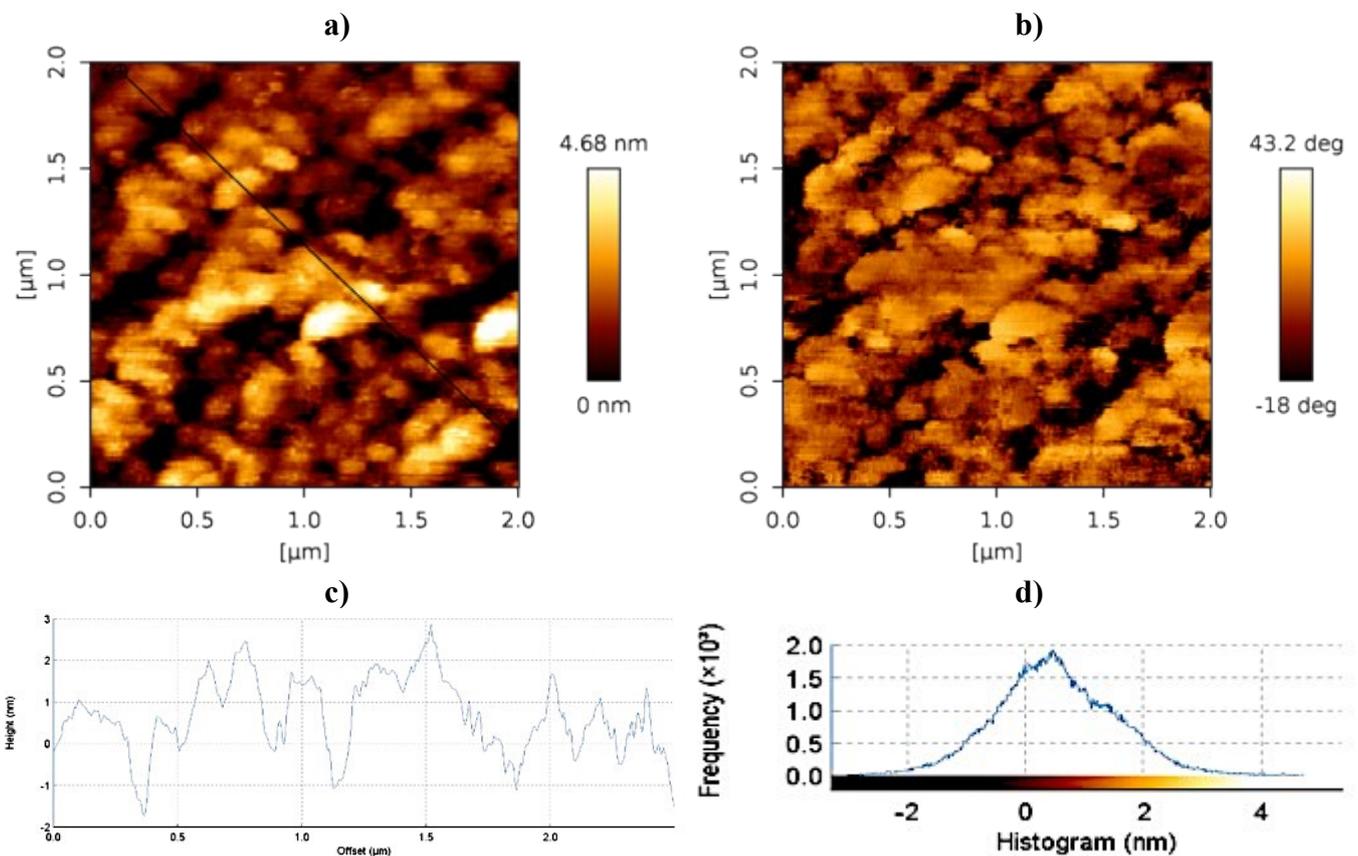


Fig. S9. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 456 (graphene synthesis conditions were: H₂ flow was 150 sccm, CH₄ flow was 50 sccm, power 0.7 kW, time 50 min, pressure 22 mBar, temperature 900 °C).

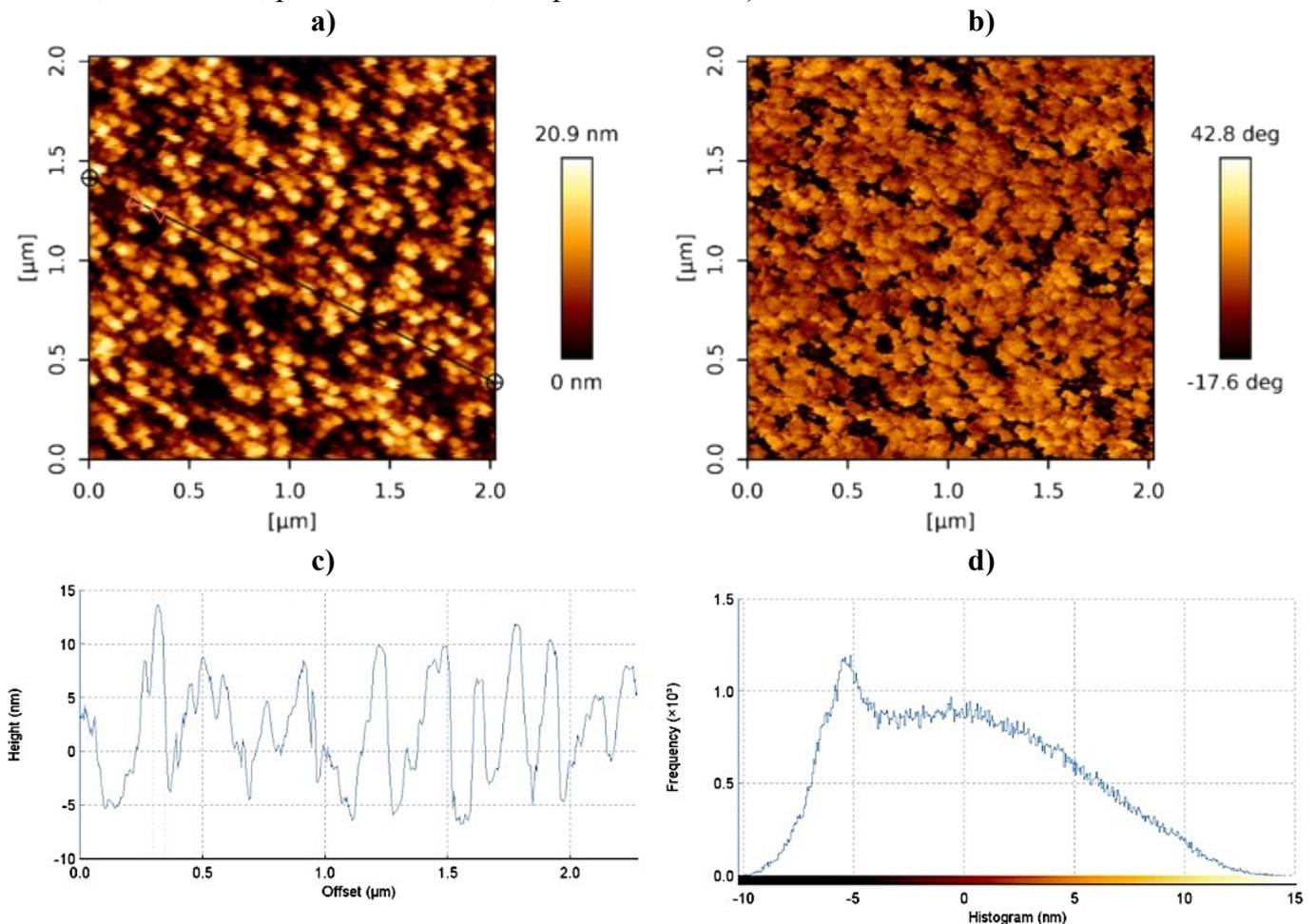


Fig. S10. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 464 (graphene synthesis conditions were: H₂ flow was 150 sccm, CH₄ flow was 50 sccm, power 0.7 kW, time 50 min, pressure 10 mBar, temperature 900 °C).

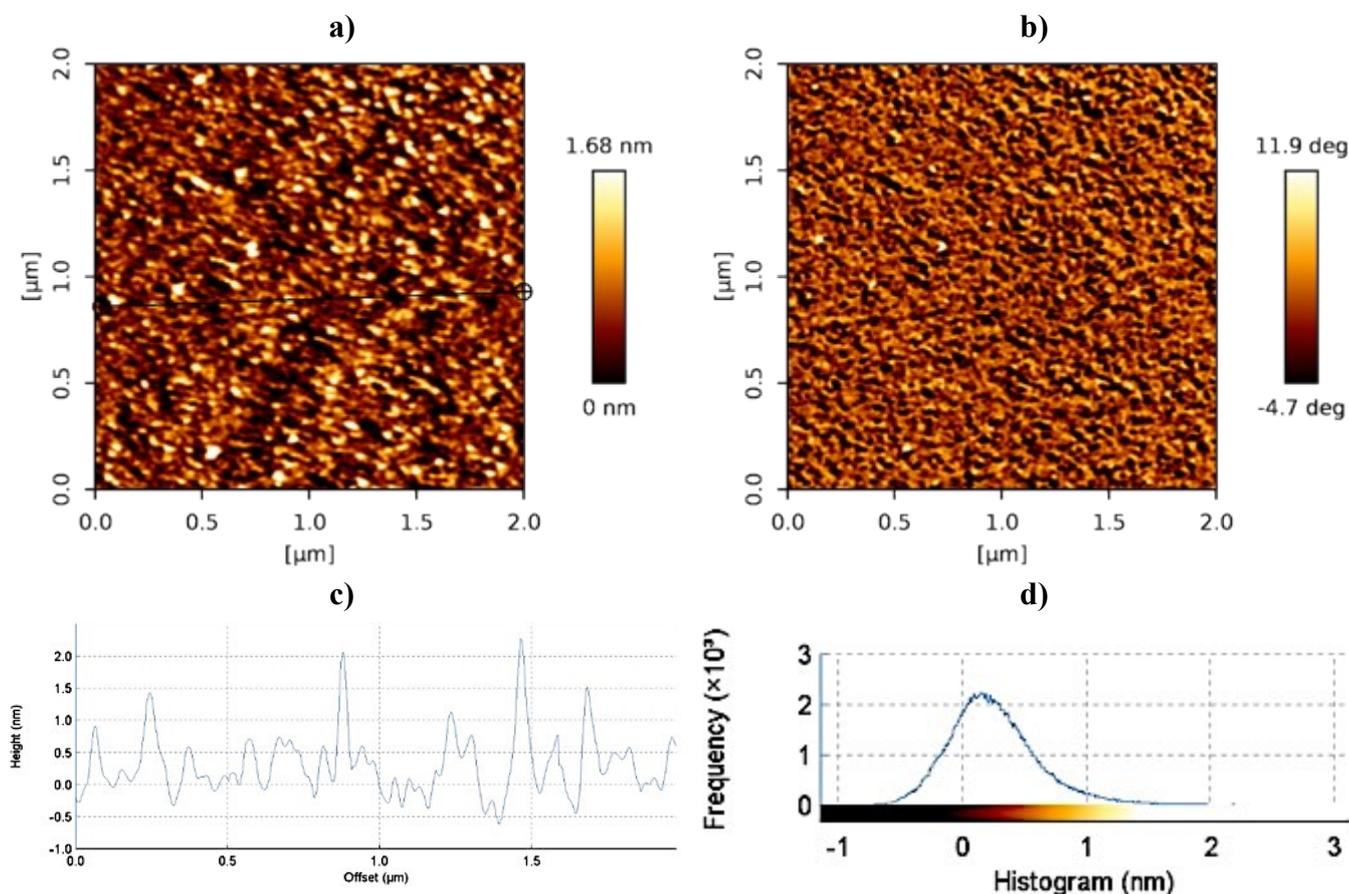


Fig. S11. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 475 (graphene synthesis conditions were: H₂ flow was 75 sccm, CH₄ flow was 35 sccm, power 0.7 kW, time 50 min, pressure 10 mBar, temperature 700 °C).

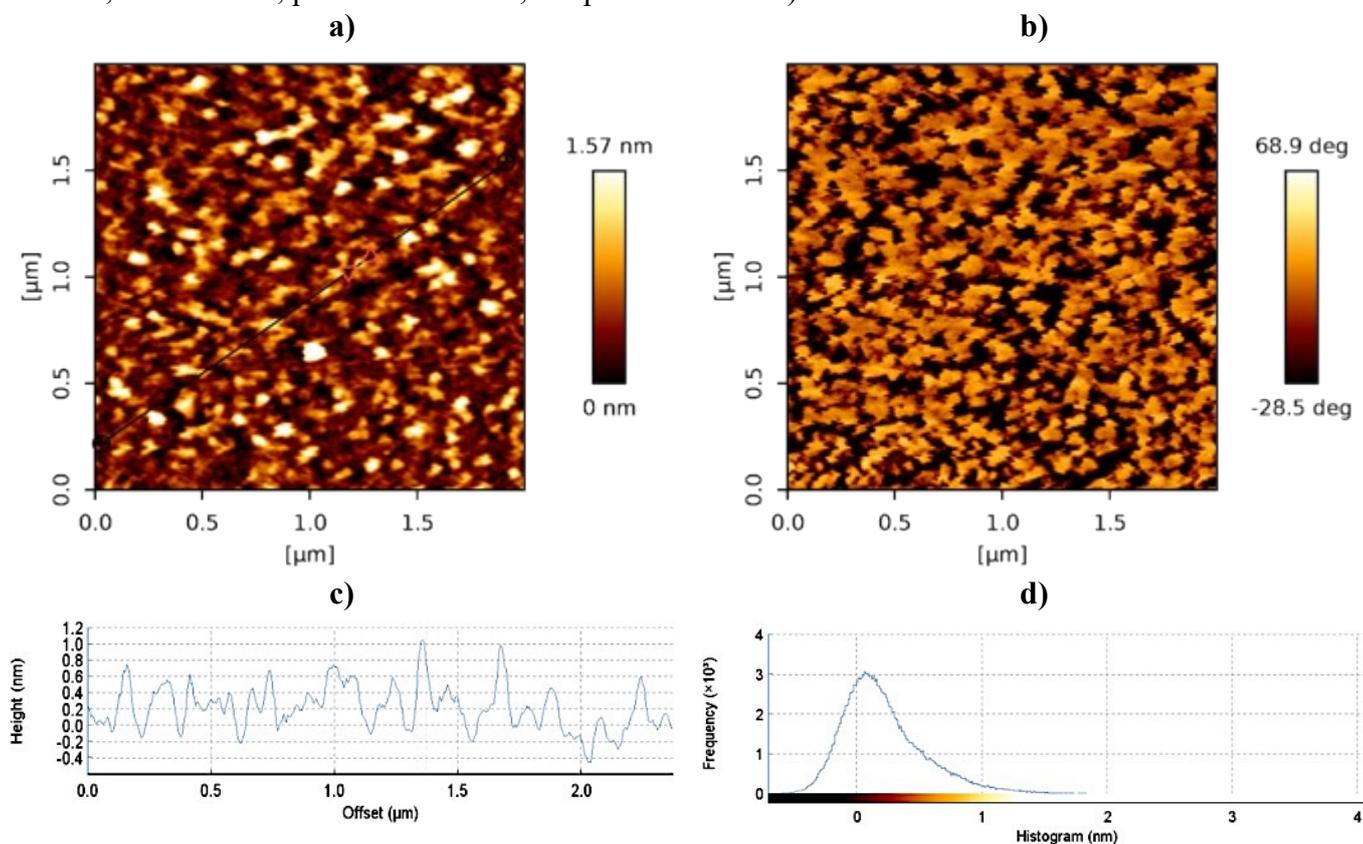


Fig. S12. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 471 (graphene synthesis conditions were: H₂ flow was 75 sccm, CH₄ flow was 35 sccm, power 0.7 kW, time 50 min, pressure 22 mBar, temperature 700 °C)

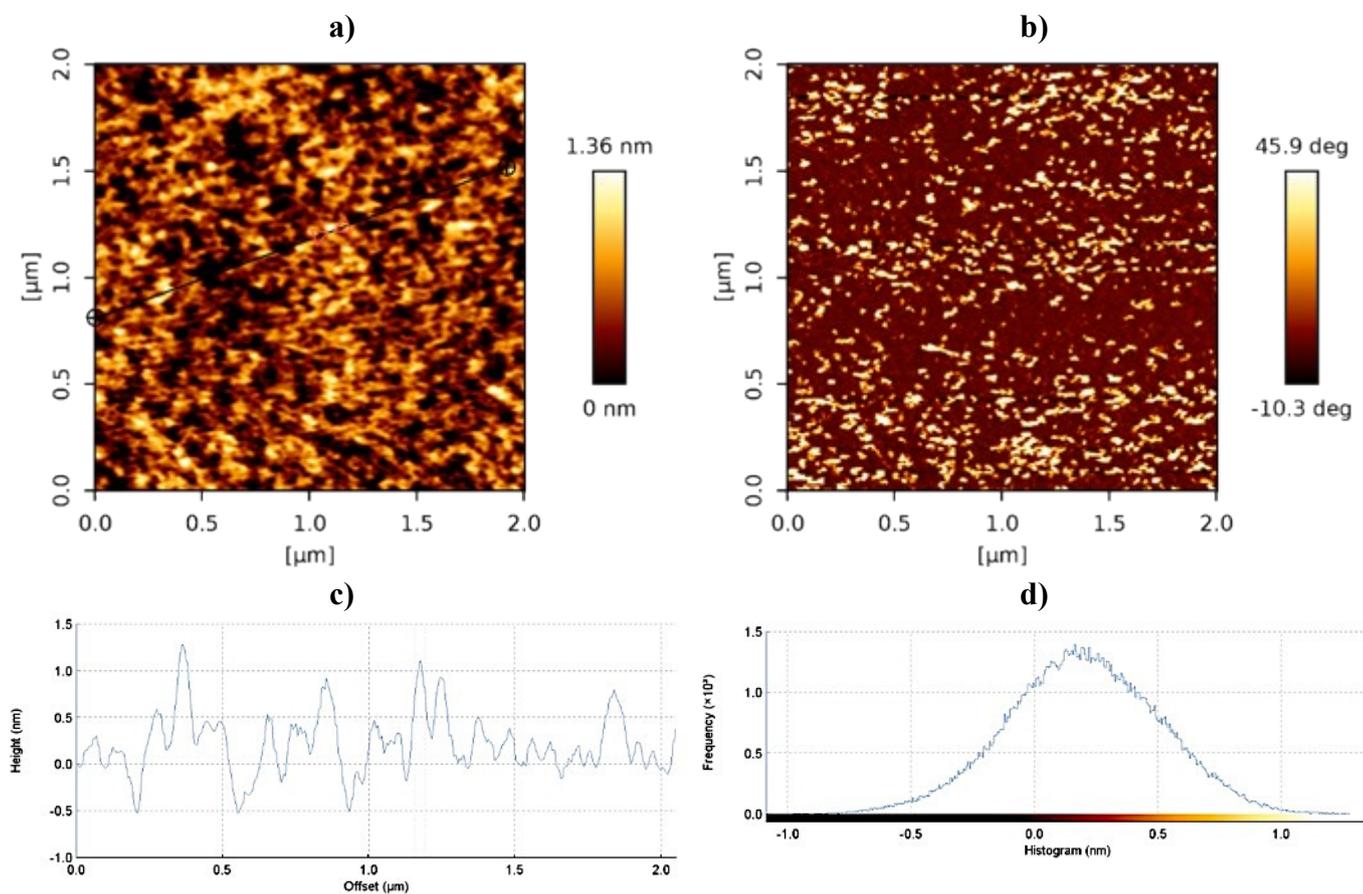


Fig. S13. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 470 (graphene synthesis conditions were: H₂ flow was 75 sccm, CH₄ flow was 25 sccm, power 0.7 kW, time 50 min, pressure 10 mBar, temperature 700 °C).

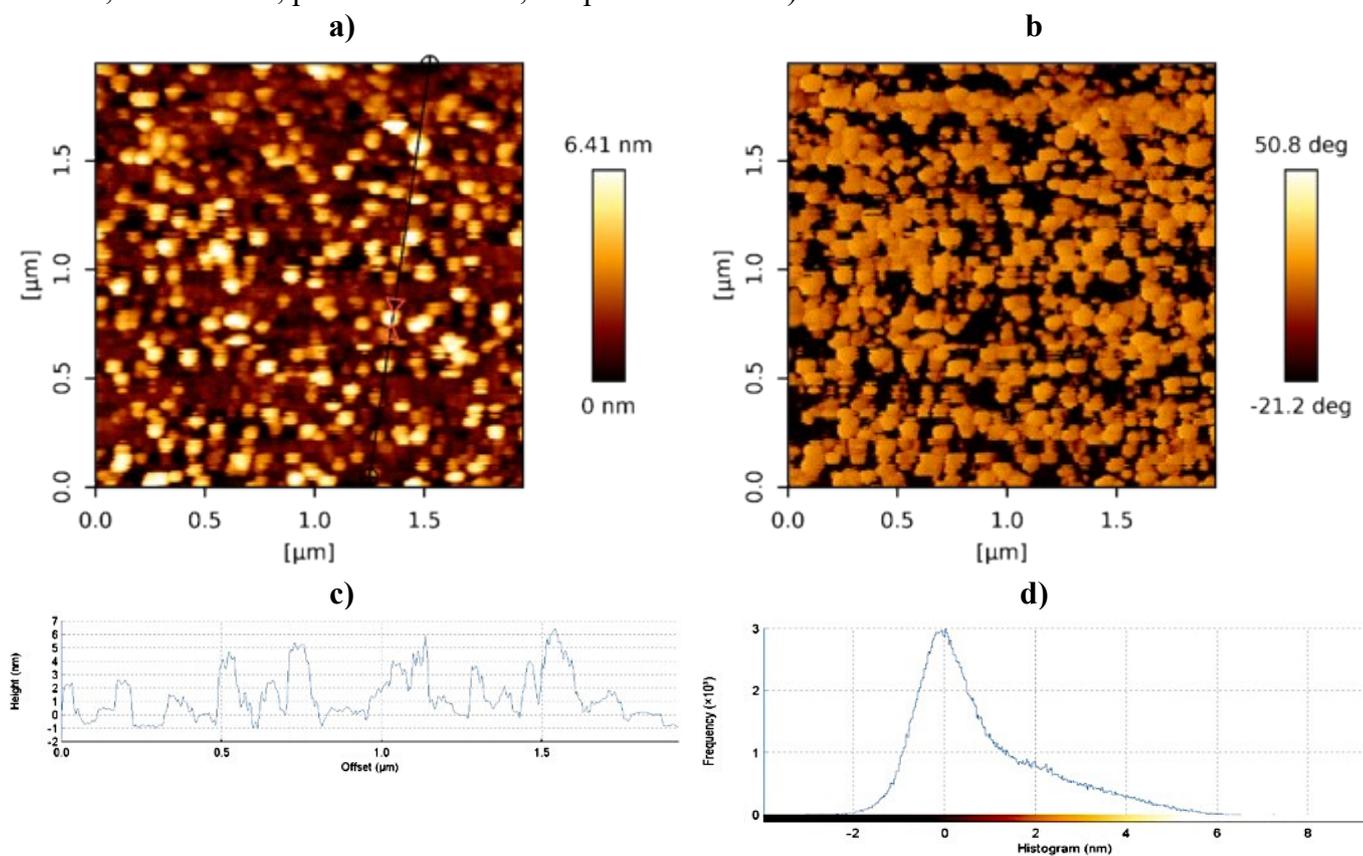


Fig. S14. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 447 (graphene synthesis conditions were: H₂ flow was 150 sccm, CH₄ flow was 50 sccm, power 1.7 kW, time 50 min, pressure 22 mBar, temperature 700 °C).

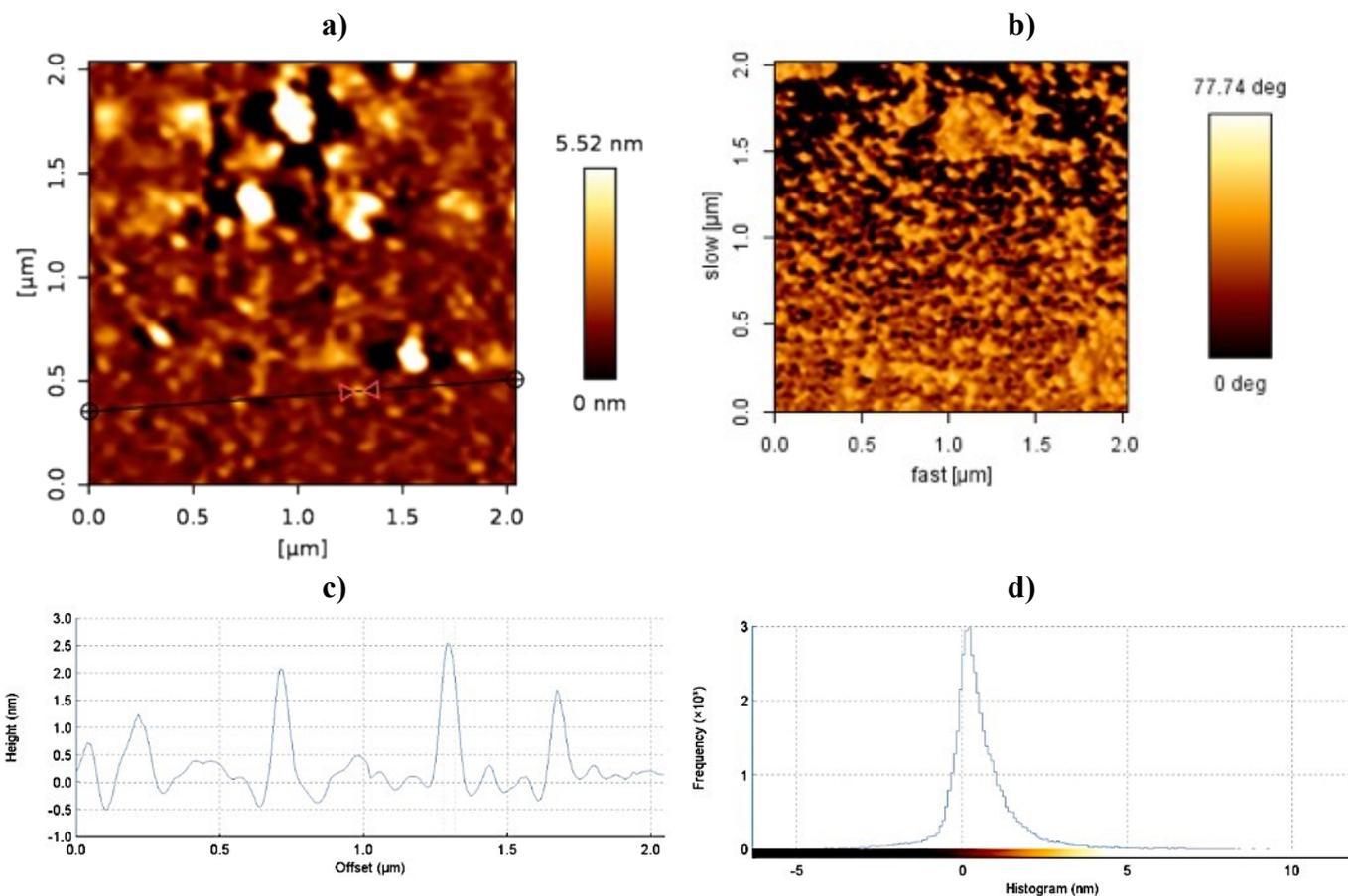


Fig. S15. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 465 (graphene synthesis conditions were: H₂ flow was 150 sccm, CH₄ flow was 50 sccm, power 0.7 kW, time 50 min, pressure 10 mBar, temperature 800 °C).

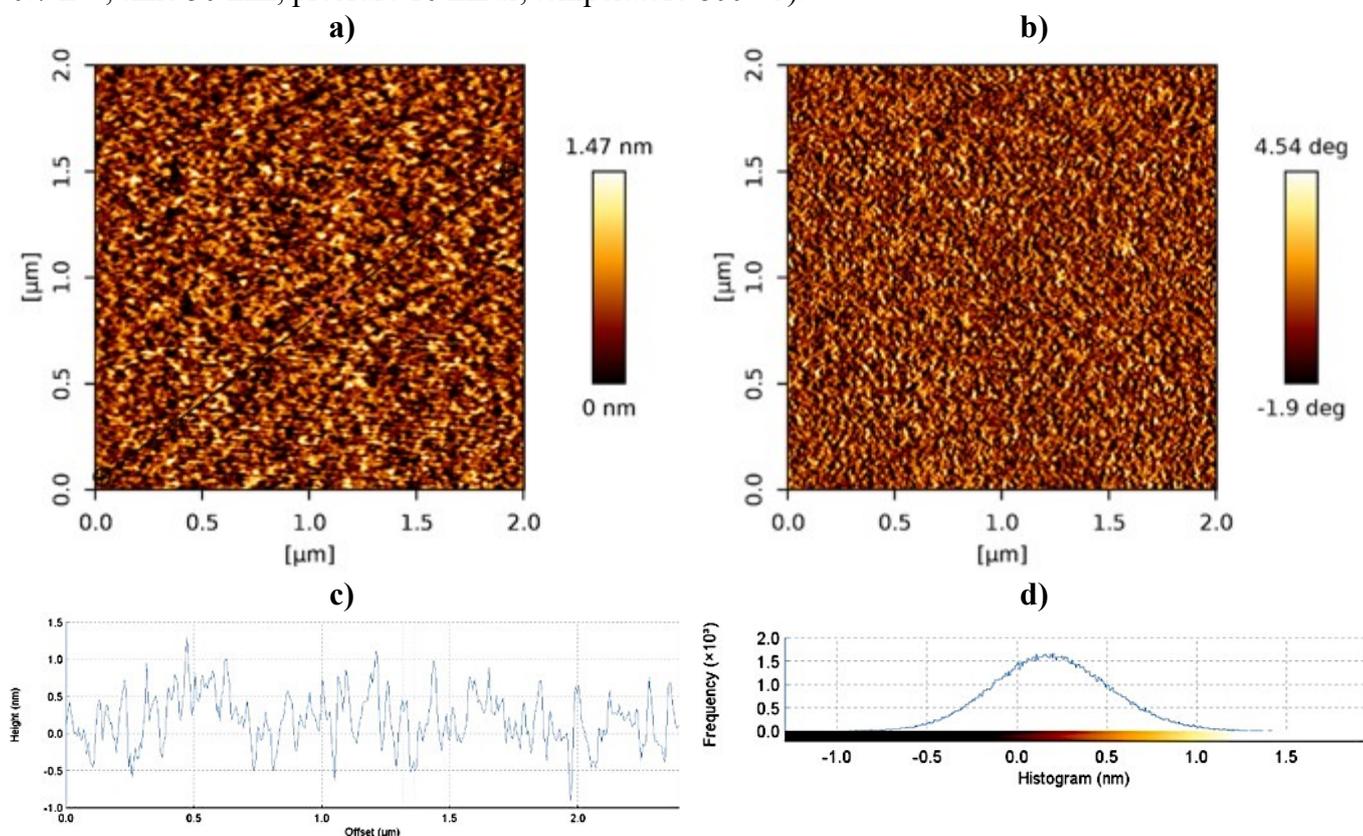


Fig. S16. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 467 (graphene synthesis conditions were: H₂ flow was 150 sccm, CH₄ flow was 50 sccm, power 0.7 kW, time 50 min, pressure 10 mBar, temperature 700 °C).

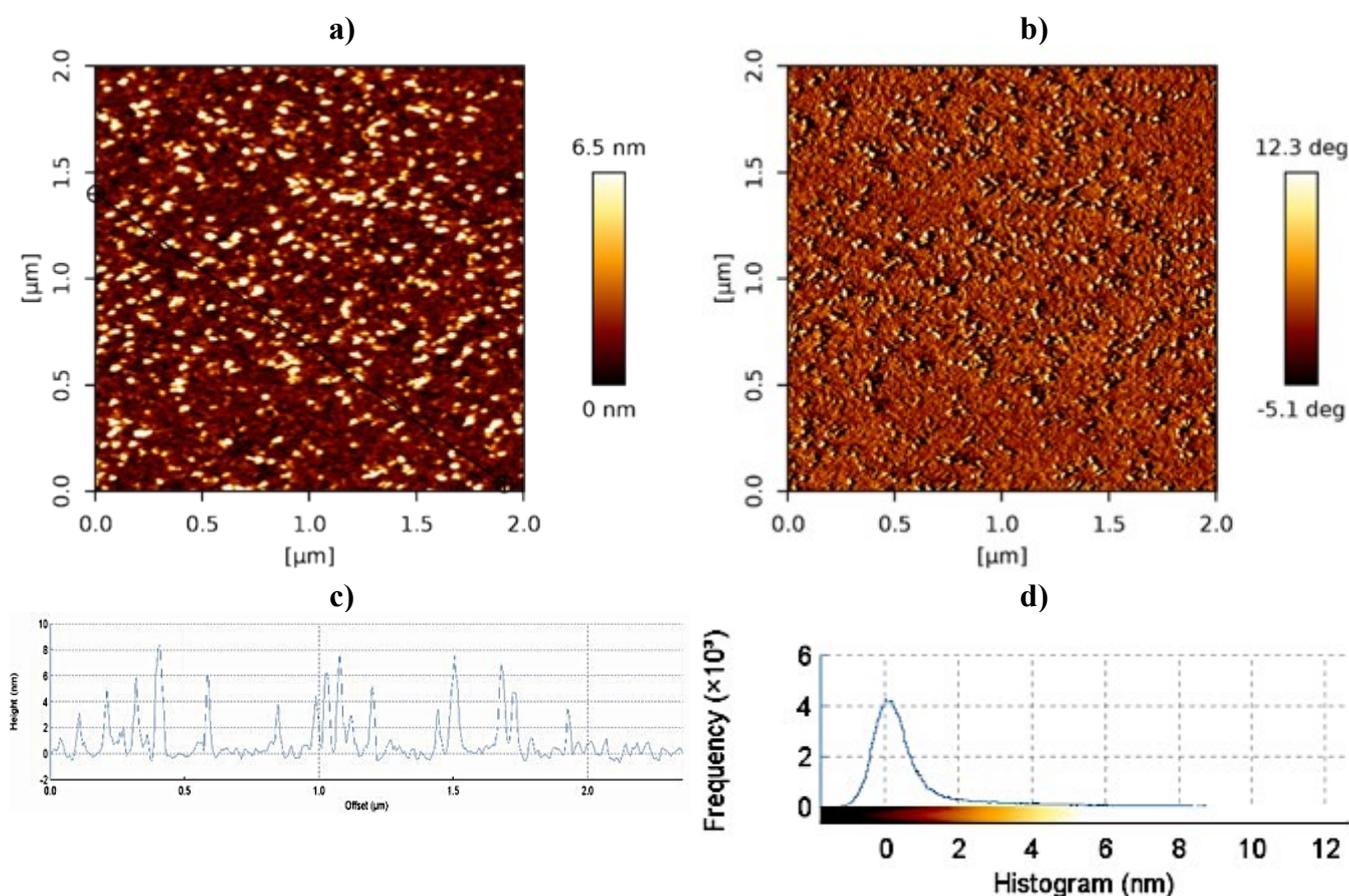


Fig. S17. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 468 (graphene synthesis conditions were: H₂ flow was 75 sccm, CH₄ flow was 25 sccm, power 0.7 kW, time 50 min, pressure 10 mBar, temperature 900 °C).

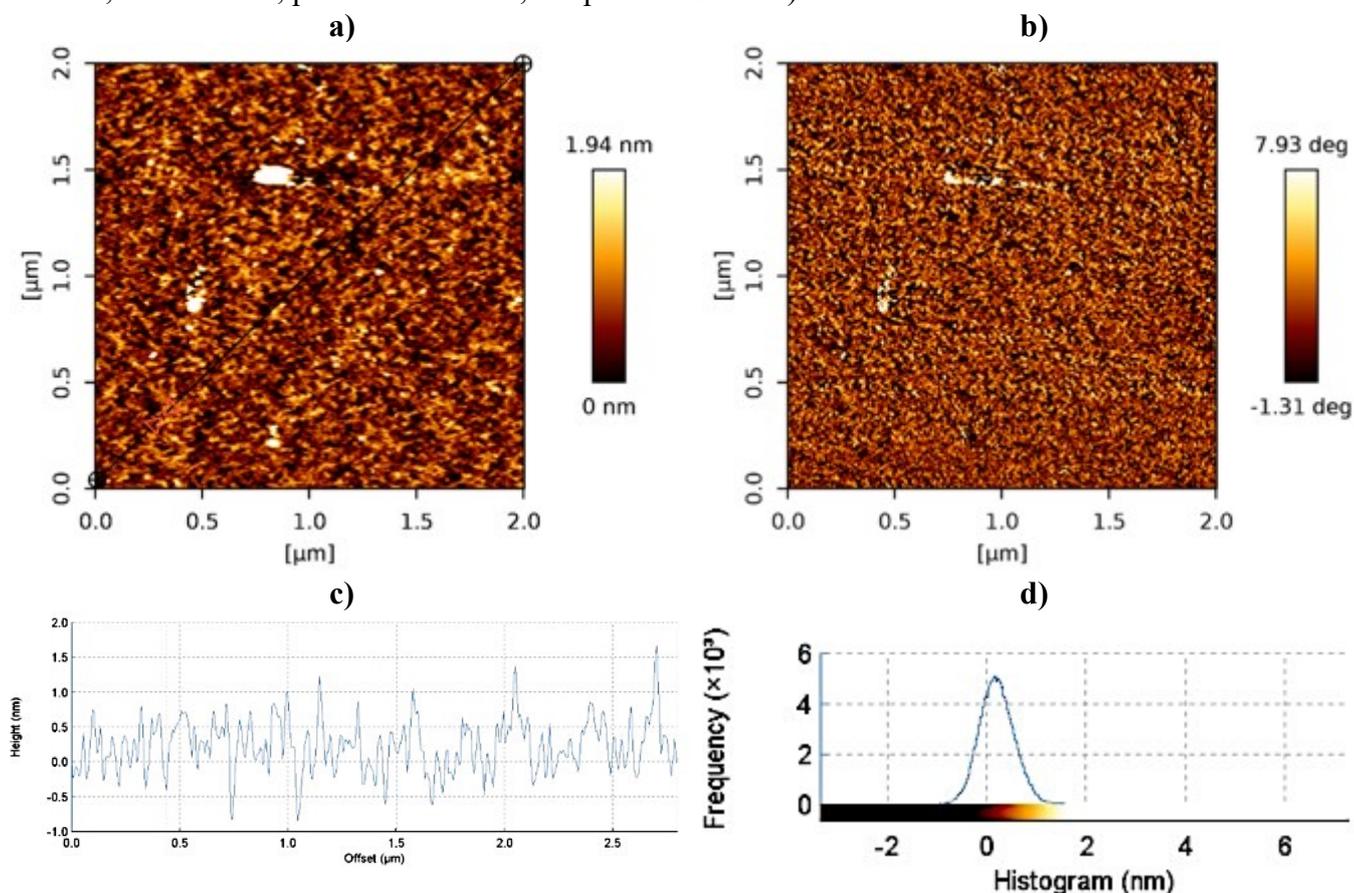


Fig. S18. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 469 (graphene synthesis conditions were: H₂ flow was 75 sccm, CH₄ flow was 25 sccm, power 0.7 kW, time 50 min, pressure 10 mBar, temperature 800 °C).

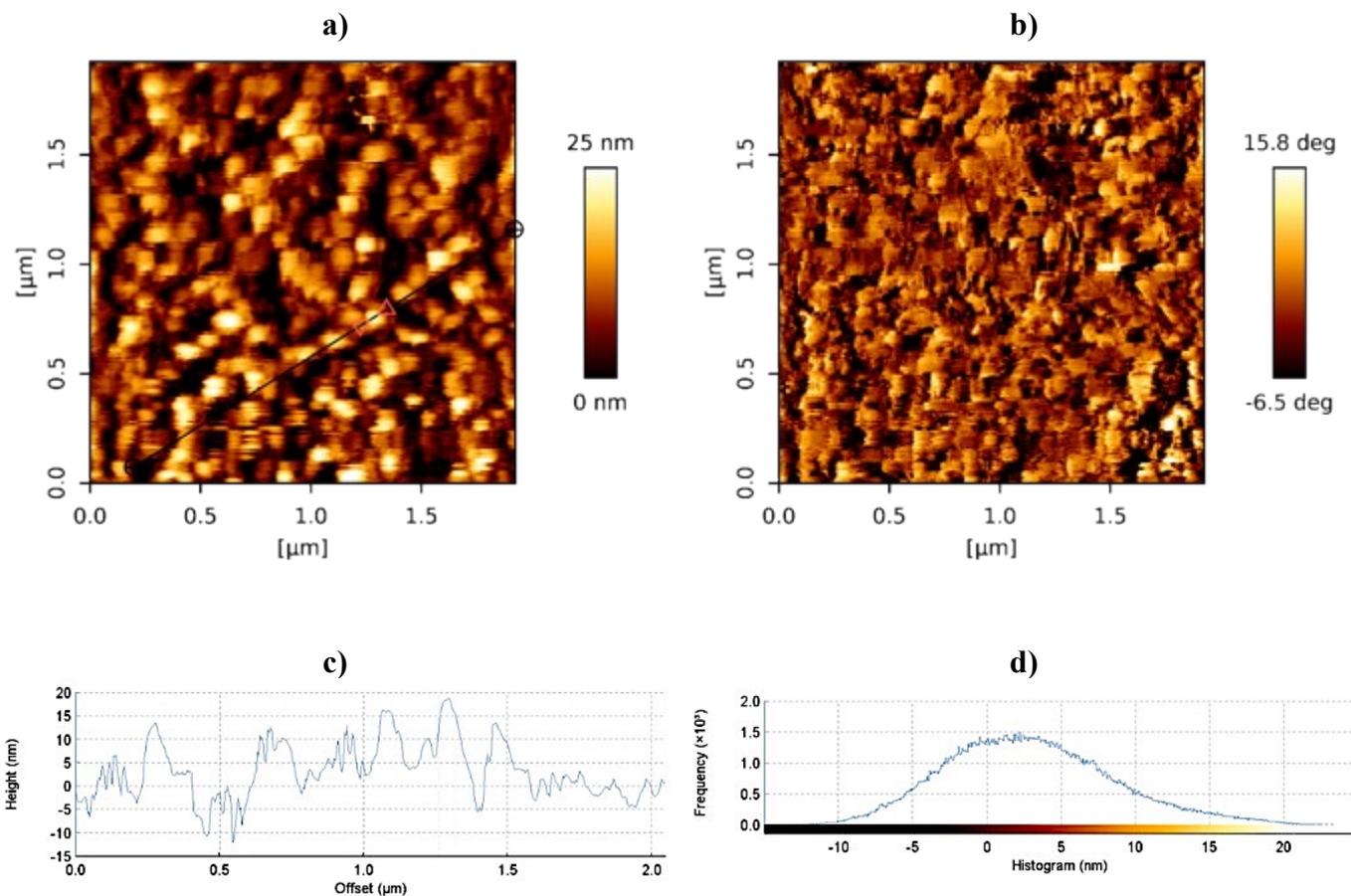


Fig. S19. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 441 (graphene synthesis conditions were: H₂ flow was 150 sccm, CH₄ flow was 50 sccm, power 1.7 kW, time 90 min, pressure 22 mBar, temperature 900 °C).

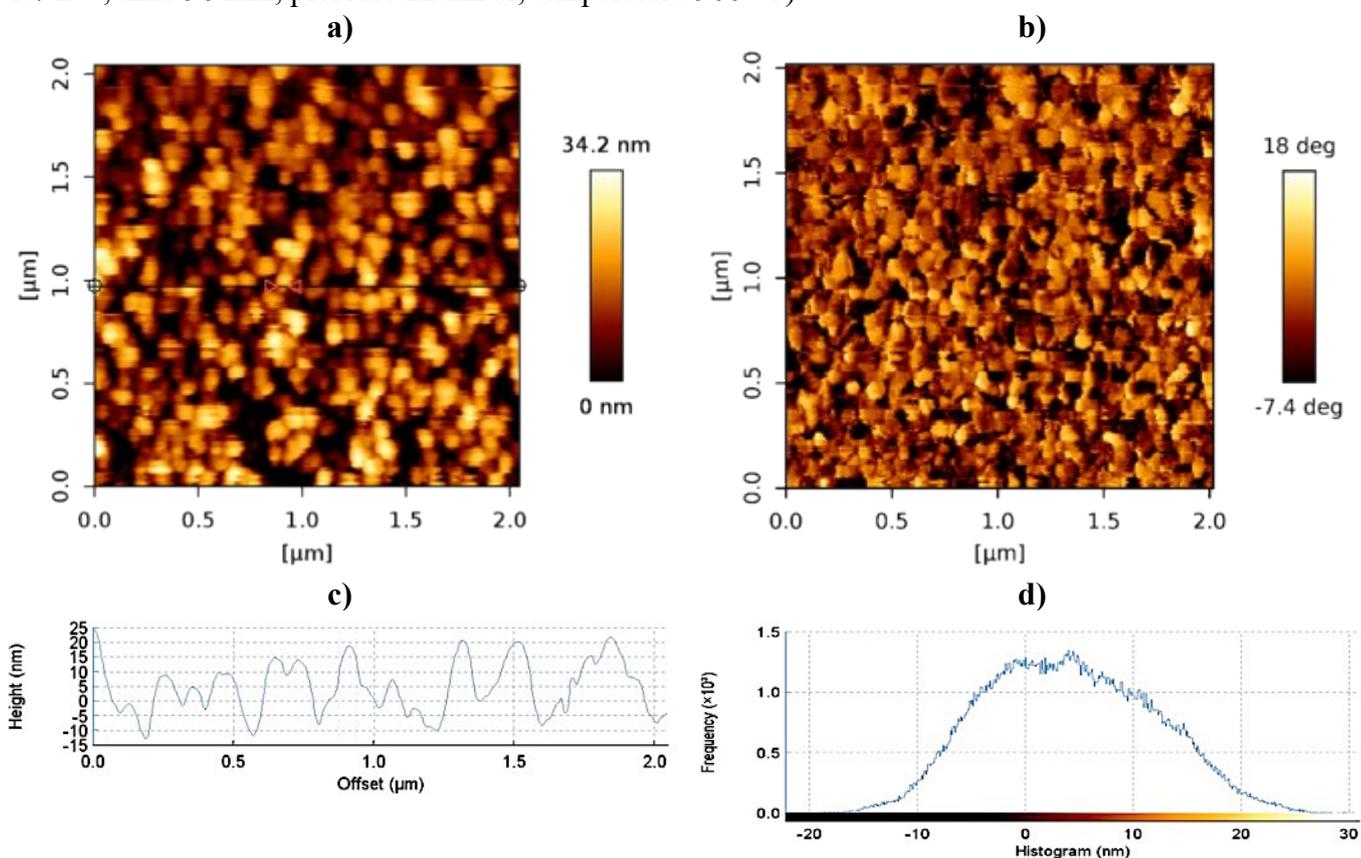


Fig. S20. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 443 (graphene synthesis conditions were: H₂ flow was 150 sccm, CH₄ flow was 50 sccm, power 1.7 kW, time 70 min, pressure 22 mBar, temperature 900 °C).

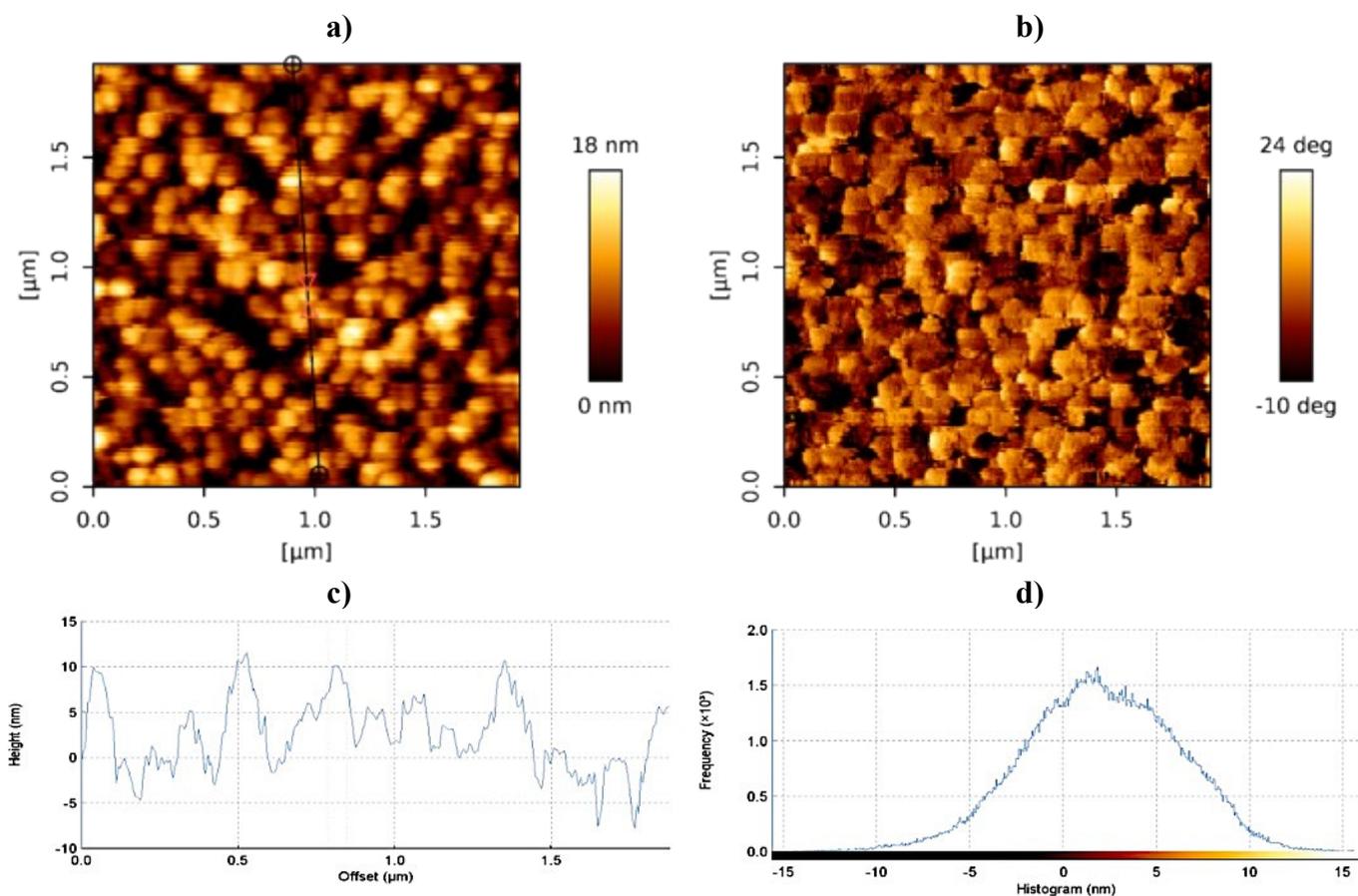


Fig. S21. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 445 (graphene synthesis conditions were: H_2 flow was 150 sccm, CH_4 flow was 50 sccm, power 1.7 kW, time 30 min, pressure 22 mBar, temperature 900 °C).

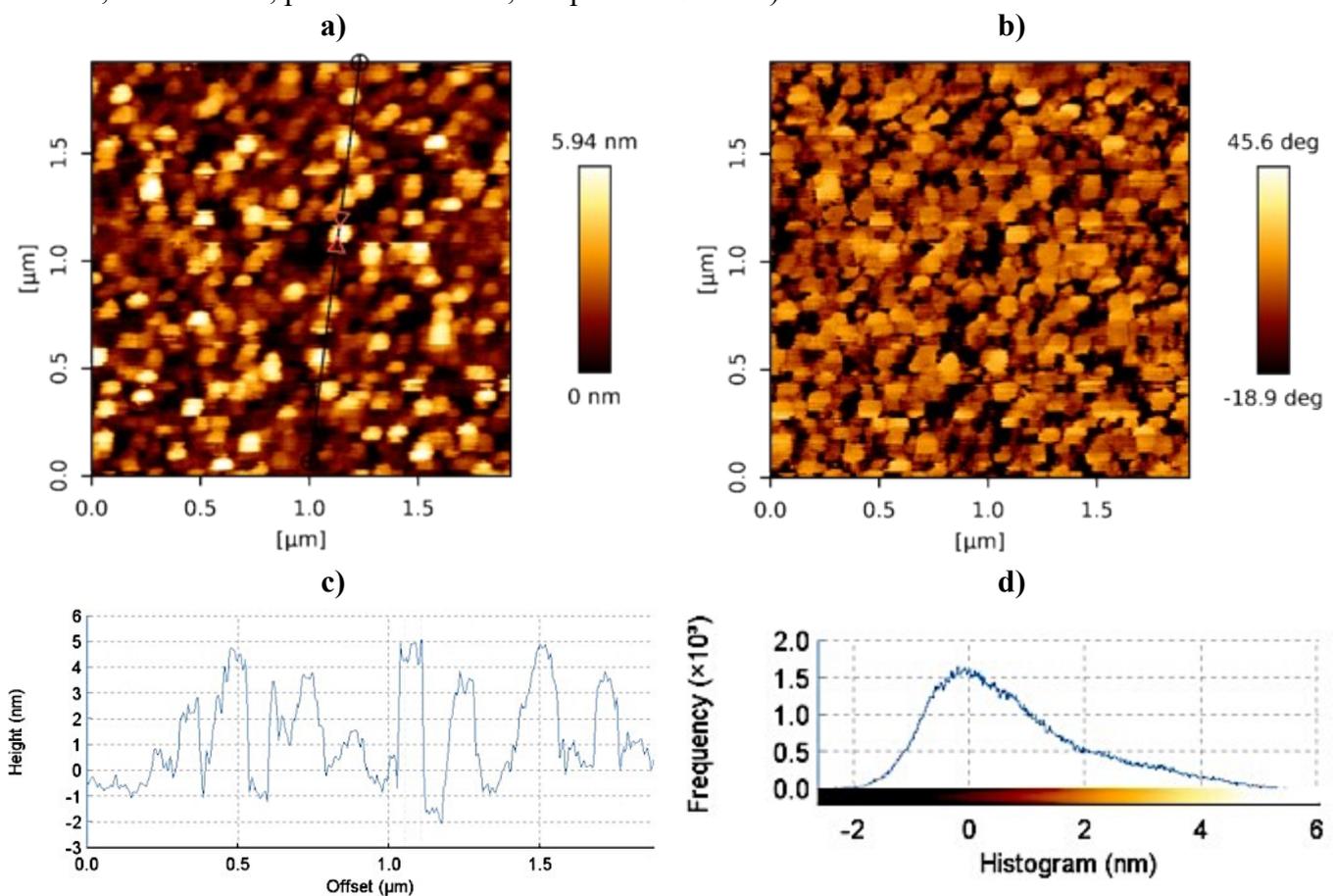


Fig. S22. morphology (a) and phase (b) height profile (c), 2D views, graphene heights histogram (d) of the sample 446 (graphene synthesis conditions were: H_2 flow was 150 sccm, CH_4 flow was 50 sccm, power 1.7 kW, time 10 min, pressure 22 mBar, temperature 900 °C).

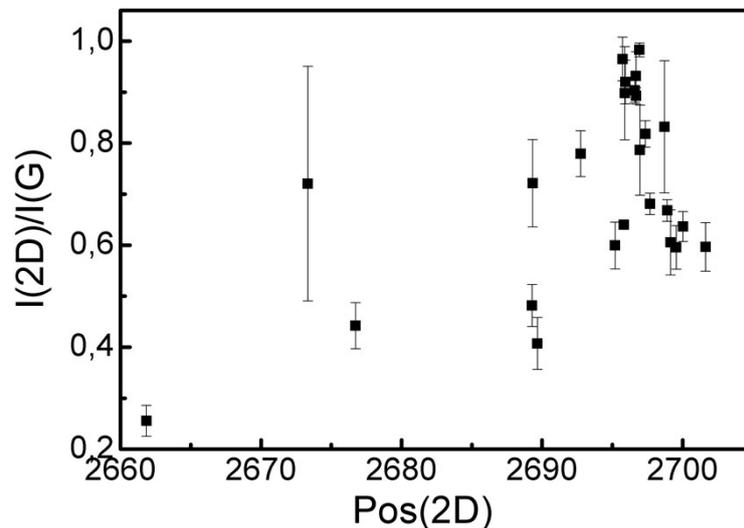


Fig. S23. I(2D)/I(G) ratio vs. Pos(2D).

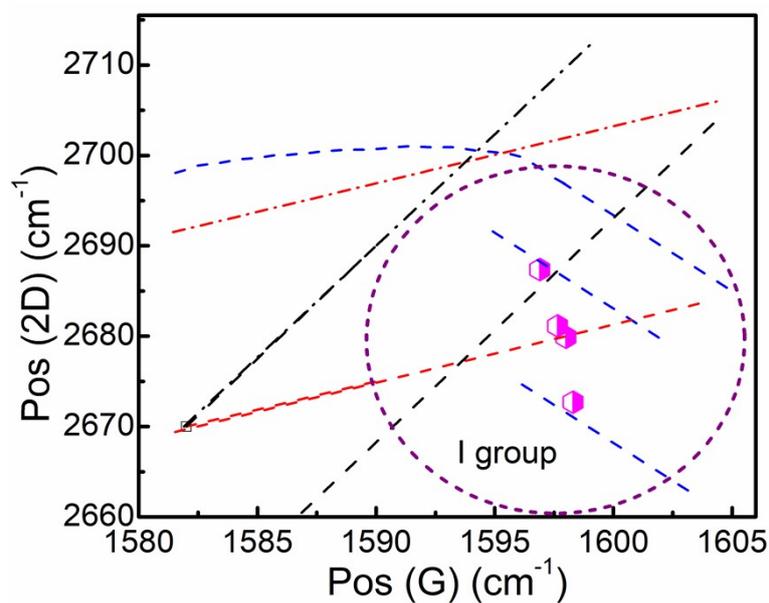


Fig. S24. Pos(2D) vs. Pos(G) plot for graphene sample synthesized on p-type Si(100). The parameters were evaluated for Raman spectra measured at different places of the sample.

References

1. Childres, I.; Jauregui, L. A.; Tian, J.; Chen, Y. P. Effect of oxygen plasma etching on graphene studied using Raman spectroscopy and electronic transport measurements. *New J. Phys.* **2011**, 13(2), 025008. DOI: 10.1088/1367-2630/13/2/025008