Not so transparent

As with the ongoing debate on the degree of wetting transparency of supported graphene, transparency in both pre- and post-publication peer review is a contentious concept.

Coat a substrate with a monolayer of graphene, and the monolayer should not alter the substrate's wetting behaviour provided that van der Waals forces are dominant. That is essentially the main message of the paper by Nikhil Koratkar and colleagues published in *Nature Materials* in March 2012[1]. Nine months later, Daniel Blankschtein and collaborators reported in *Physical Review Letters* that graphene is not entirely transparent to wetting, in particular for superhydrophilic and superhydrophobic substrates[2]. Evelyn Wang and co-workers stated in March 2013 in *Nano Letters* that the underlying substrate does not affect the wettability of graphene coatings[3]. Intriguingly, such conflicting claims of complete, partial and null wetting transparency were all supported by water contact-angle experiments, molecular dynamics simulations and wetting theory.

Yet there is more to the story. On page 925 in this issue, Lei Li, Haitao Liu and colleagues assert that graphitic surfaces are not hydrophobic — as has long been assumed — but intrinsically (mildly) hydrophilic[4]. Using both contact-angle and spectroscopy experiments as well as theoretical analysis, they show that volatile hydrocarbons — commonly present in air — readily adsorb on graphitic surfaces, making them substantially more hydrophobic in a matter of minutes. Also, their data is in agreement with the partial-wetting-transparency view.

Some may find Li, Liu and co-workers' findings unsurprising. Indeed, it has long been known that airborne hydrocarbons adsorb on many metals and oxides and lower their surface energy. In 2012, this phenomenon was also shown for the aptly named 'white graphene' (that is, hexagonal boron nitride)[5]. Then, why would graphene be special in this regard? Actually, it isn't. What is surprising is that scientists in the field assumed nonpolar, all-carbon surfaces to be hydrophobic in the absence of careful validation.

As Ke Xu and James Heath write in a News & Views article on page 872, if the wetting properties of graphene are strongly affected by contamination, it is perhaps expected that a supporting substrate can also influence graphene's wetting behaviour[6]. In fact, the contact angle of water on highly ordered pyrolytic graphite is higher than that of water on supported (monolayer and few-layer) graphene, which indicates that the monolayer cannot be opaque to van der Waals interactions[1,4]. It is therefore likely that the partial-transparency interpretation will stand the test of time. In a Commentary on page 866, Chih-Jen Shih, Michael Strano and Daniel Blankschtein add that, according to a simple analysis involving only pairwise interactions, graphene should transmit about 30% of the van der Waals interactions between water and the supporting substrate[7]. Still, it is not obvious what the extent of the effect of (non-additive) many-body interactions may be. Also, impurities, partial charges and surface defects, including step edges, may all influence the wetting properties. Indeed, defects may interact more strongly with water[7] and be hotspots for the nucleation of adsorbents[6]. In light of the apparently stronger water–graphene interaction, which remains to be explained at the atomic level, most wetting models for graphitic surfaces would need to be revisited[4]. At a more practical level, the performance of graphene-based devices may be more sensitive than expected to environmental humidity and contamination from volatile organic compounds[6].

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It is clear that much remains to be explained and, hence, we do not expect this scientific debate to wane. Rather, it suggests that, if substantial findings with potential wide implications become rapidly visible, the relevant scientific communities will work to correct misguided interpretations. Also, journals should not shy away from publishing surprising or potentially controversial results that are likely to challenge current views and generate scientific debate. More generally, scientific debates can be highly demanding. Peer review can be subject to one-sided arguments and rigid views, and the publication of results that are perceived to be controversial can affect the development of the field and the journal's reputation (for better or worse). Editorial decisions should thus be the result of best judgment applied to the appropriate scientific context after all the available arguments (not the votes in favour of publication) in a thorough peer-review process have been considered.

Despite all the benefits that open, interactive[8] or transparent[9] peer review can bring (as exemplified by the Frontiers journals[10]), in many cases reviewer anonymity is indispensable and double-blind peer review could be helpful. In all cases, incorporation of relevant discussion between authors and reviewers in the final version of the paper or its supplementary information ought to be encouraged. Even if unconditional full transparency remains a utopia, partial transparency could be promoted by publishing anonymous referees' comments, rebuttal and decision letters when there is support from all parties involved. Discussions after publication — through peer-reviewed correspondence, or in blogs and post-publication peer-review services such as Faculty of 1000 and PubPeer — can also enhance the value of a paper and provide additional context. However, where expert mediation is absent, the occasional dominant partisan views or, even worse, anonymous slander, can be all too detrimental to science. As much as we all benefit from open dialogue, we should recognize that the processes of assessing science (including peer review, and grant and hiring evaluations) can be rather subjective and not always fully transparent. ❐

References

1. Rafiee, J. *et al. Nature Mater.* **11,** 217–222 (2012).
2. Shih, C-J. *et al. Phys. Rev. Lett.* **109,** 176101 (2012).
3. Raj, R., Maroo, S. C. & Wang, E. N. *Nano Lett.* **13,** 1509–1515 (2013).
4. Li, Z. *et al. Nature Mater.* **12,** 925–931 (2013).
5. Boinovich, L. B. *et al. Langmuir* **28,** 1206–1216 (2012).
6. Xu, K. & Heath, J. R. *Nature Mater.* **12,** 872–873 (2013).
7. Shih, C-J., Strano, M. S. & Blankschtein, D. *Nature Mater.* **12,** 866–869 (2013).
8. http://dx.doi.org/10.1126/science.caredit.a1300068
9. *Nature Mater.* **10,** 81 (2011).
10. http://www.frontiersin.org/about/reviewsystem