ABSTRACT
Experiments, molecular dynamics simulations, and theory demonstrate that the wettability of graphene coated substrate closely matches the wettability of graphite

- Test samples: Mono-/bi-/tri-layered graphene sheets on Cu, SiO$_2$, and glass
- Test fluid: De-ionized water
- Experimental observations:
  - High contact angle hysteresis (16° – 37°)
  - Advancing contact angle independent of number of graphene layers
  - Receding contact angle influenced by defects in graphene
- MD and theoretical results agree with advancing contact angles measurements
- Large interlayer spacing responsible for negligible substrate effect on wettability
- Negligible substrate effect was apparent on the advancing contact angle of water on few layer graphene for all substrates
- The advancing contact angle with a monolayer graphene matched those on HOPG
- Significant contact angle hysteresis was observed on all samples
- Transferred graphene coatings demonstrated maximum contact angle hysteresis

EXPERIMENTS
- Dynamic contact angle experiments were performed on three bare substrates (Cu, SiO$_2$, and Glass), nine graphene samples (mono-, bi-, tri-layered graphene), and graphite (HOPG)
- Condensation experiments with monolayer graphene on SiO$_2$ substrate were performed in the enclosed chamber of an Environmental Scanning Electron Microscope
- Dropwise condensation confirmed the hydrophobic nature of monolayer graphene coatings
- Contact angle of 85° – 92° was observed during the droplet growth phase
- Significant contact line pinning time and hysteresis were also observed during these experiments

MOLECULAR DYNAMICS (MD)
- Negligible substrate effect was apparent on the contact angle of water on monolayer graphene, both for Cu and SiO$_2$
- The simulated contact angles match with the experimental advancing contact angles
- The discrepancy between the experimental and simulated values for monolayer graphene on Cu is attributed to the partial oxidation of Cu underneath the graphene grain boundaries

ANALYSIS
- MD and experimental advancing angle values compare well with the 3-9 potential
- Evaluation of solid-liquid equilibrium distance critical for the correct estimation of contact angle
- The large interlayer spacing in graphene based systems minimize the effect of substrate

CHARACTERIZATION
- AFM measurements confirmed that the roughness ratio was negligible (~1.004)
- Visualization of the contact line revealed local contact pinning on such smooth surfaces
- Raman spectroscopy measurements visualized holes (solid arrows) in transferred graphene coatings which act as heterogeneity on these otherwise homogenous coating resulting in the observed hysteresis

CONCLUSIONS
- Substrate has negligible effect on the wettability of graphene
- Advancing contact angle is representative of the actual graphene coating
- Receding contact angle is affected by defects in as grown and transferred graphene coatings
- Continuum models invalid due to the large interlayer spacing in graphene based substrates