Choi and Kim Reply: The preceding Comment [1] correctly points out three potential errors in the rheometry experiment. Although the details were not in [2], the analysis and treatment of errors had been considered in the implementation of the study, with the conclusion that the experiments were valid.

(i) Uncertainty in the rheometry system: Since the issue of controllability of temperature was discussed in [2] (uncertainty of $\sim 2\ \mu$m in slip length or $\sim 0.3\%$ in torque), here we discuss the next two issues in the system: torque resolution and gap sizing. The torque resolution of the AR 2000 system (1 nN $\cdot$ m [3]) is less than 0.05% of the torque covered in our experiment (2–15 μN $\cdot$ m), making the uncertainty of the torque resolution negligible. With the resolution of the gap size setting reported as 0.06 μm [3], the gap sizing error resides mainly with the nonflat surface of the sample. On our nanoturf surface with 1–2 μm high structures, the gap error uncertainty would be less than 0.3% of the torque even in the worst case [$\Delta M/M_0 \cong 3b/(2\theta_0 R)$; $M_0 = 2\pi\mu\Omega R^3/(3\theta_0)$; $b = 2\ \mu$m; see Fig. 1 and Eq. (5) in [2]]. Overall, the instrumental uncertainty in torque measurement is less than 0.5% ($\sqrt{0.3\%^2 + 0.05\%^2 + 0.3\%^2}$), contrary to the large standard deviation (1.4%–3.5%) reported in the benchmark experiment [1].

(ii) Inertia effects (secondary flow): Although the mathematical analyses of inertia effects [4] may be useful in estimating their likely orders of magnitude (especially when inertia effects are considerable), it would be *misleading* to seek quantitative significance in the predictions as explained in [5]. In addition to the fact that the inertia effects were not observable in our reported shear rate range [2], it should be noted that Turian's analysis for the inertia effects [4] was for systems not bounded by free surfaces.

(iii) Edge and end effects: Our validity study indicated the errors from the edge and end effects cannot be neglected. The shape of the free surface at the rim of the cone-and-plate changed according to surface wettability of the sample; the resulting effective shearing radius would vary non-negligibly were care not taken. To estimate this filling effect, hydrophilic and hydrophobic smooth surfaces were first tested as references. With the liquid volume varied by a syringe and monitored by a high-speed camera, the referential shape of the free surface yielding the expected liquid viscosity was decided on smooth surfaces with a no-slip assumption [Figs. 1(a) and 1(b)]. By filling the liquid to fit the referential shapes, we obtained a standard deviation below 0.5% in torque measurement, confirming the overall instrumental uncertainty level discussed in (i).

Free surfaces on nanoturf were then set as close as possible to those of the references. Most importantly, the effective shearing radius on hydrophobic nanoturf was maintained at less than ± 0.1 mm of its reference [Fig. 1(d)]. Neglecting the corresponding deviation of filling volume (less than 0.01 mL or 0.5% of its referential volume 1.98 mL), the misinterpretation in slip length due to shearing radius would be less than $\pm 7\ \mu$m [$\Delta\delta \cong 2\theta_0 \Delta R$, see Eq. (6) in [2]]. This error is consistent with the $\pm 5\ \mu$m deviation ($\pm 3\ \mu$m in standard deviation) in the slip length data (see Fig. 4 in [2]). Note that these results are consistent regardless of the test liquids (viscosities) and shear rates, contradicting the predictions in [1]. The distinctively clear and large slip on hydrophobic nanoturf is not blurred by the deviation and mitigates the concern over the systematic bias considered in [1].

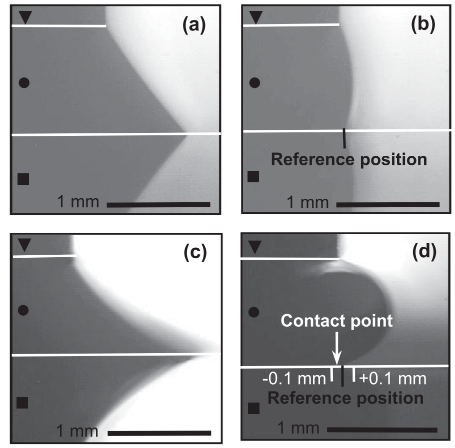

FIG. 1. Side-view pictures of the free surfaces of water at the rim of cone-and-plate geometry during experiment: (a) hydrophilic smooth surface; (b) hydrophobic smooth surface; (c) hydrophilic nanoturf surface; (d) hydrophobic nanoturf surface. For (d), the interface landed within ± 0.1 mm of the reference position for all the tests (~ 20 runs). (▼, rheometer cone; ●, water; ■, sample substrate reflecting the image of water).

All things considered, the experimental uncertainty and the potential bias are sufficiently smaller than the obtained slip length ($\sim 20\ \mu$m in water and $\sim 50\ \mu$m in glycerin). The large effective slip on the nanoengineered superhydrophobic surface [2] should remain valid.

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Received 3 May 2006; published 7 September 2006
DOI: 10.1103/PhysRevLett.97.109602
PACS numbers: 83.50.Rp, 47.45.Gx, 68.08.Bc, 81.40.Pq

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