Supporting Information for

Scalable Formation of Hybrid Graphene Nanoscrolls for High-Performance Solid Lubricants

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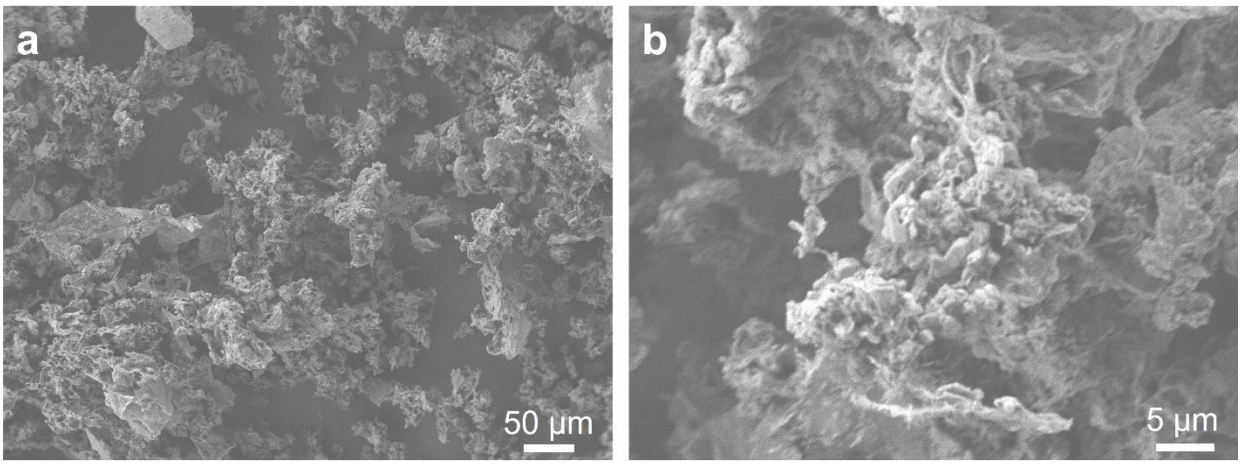

Figure S1. SEM of physical mixture of graphene and TiO_2 NPs at two different magnifications.

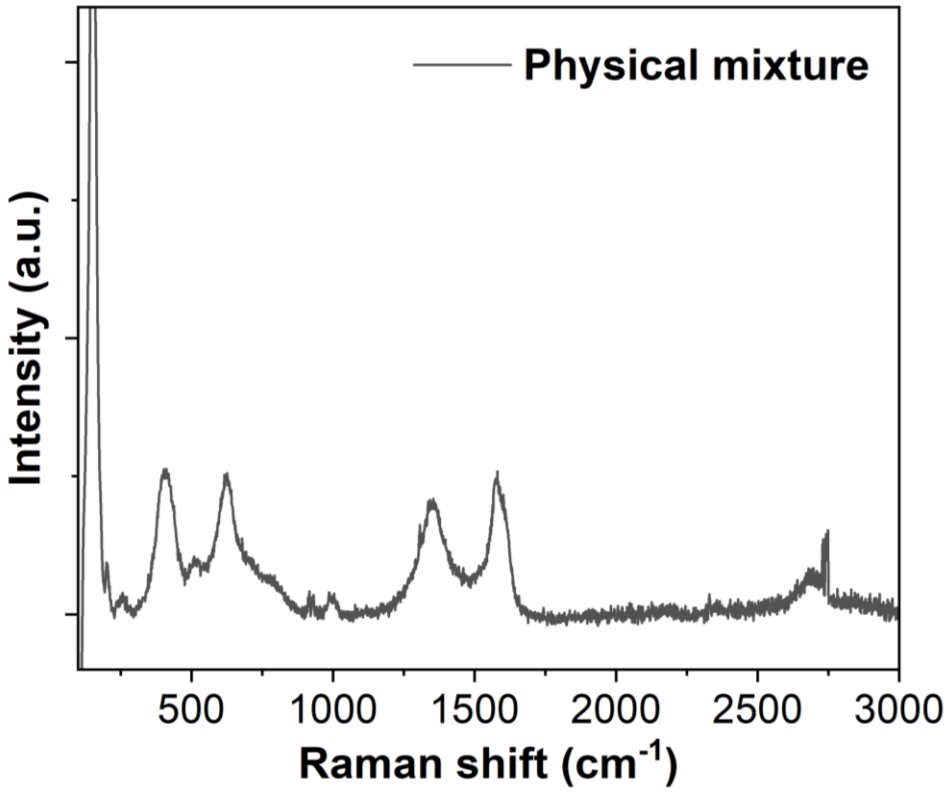

Figure S2. Raman spectrum of the physical mixture of graphene and TiO_2 NPs.

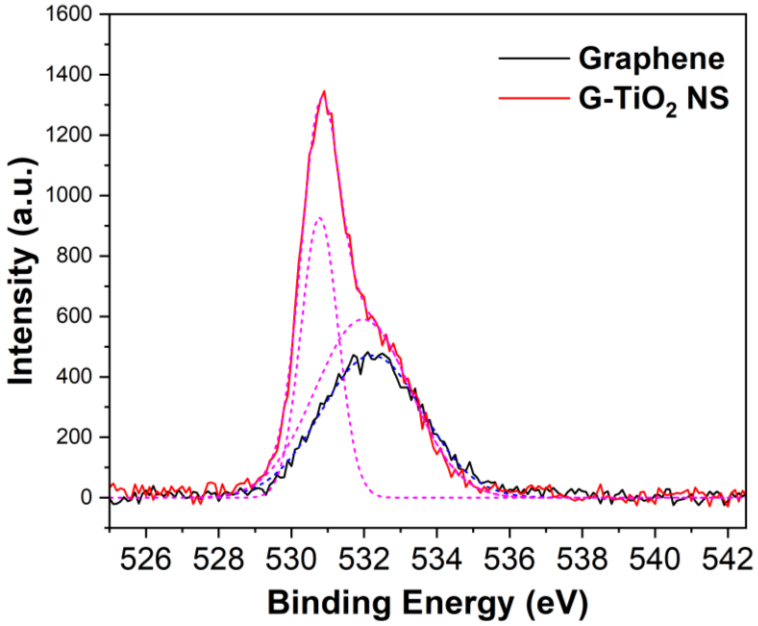

Figure S3. XPS O1s peaks and their fitting for graphene and G-TiO2 NS.

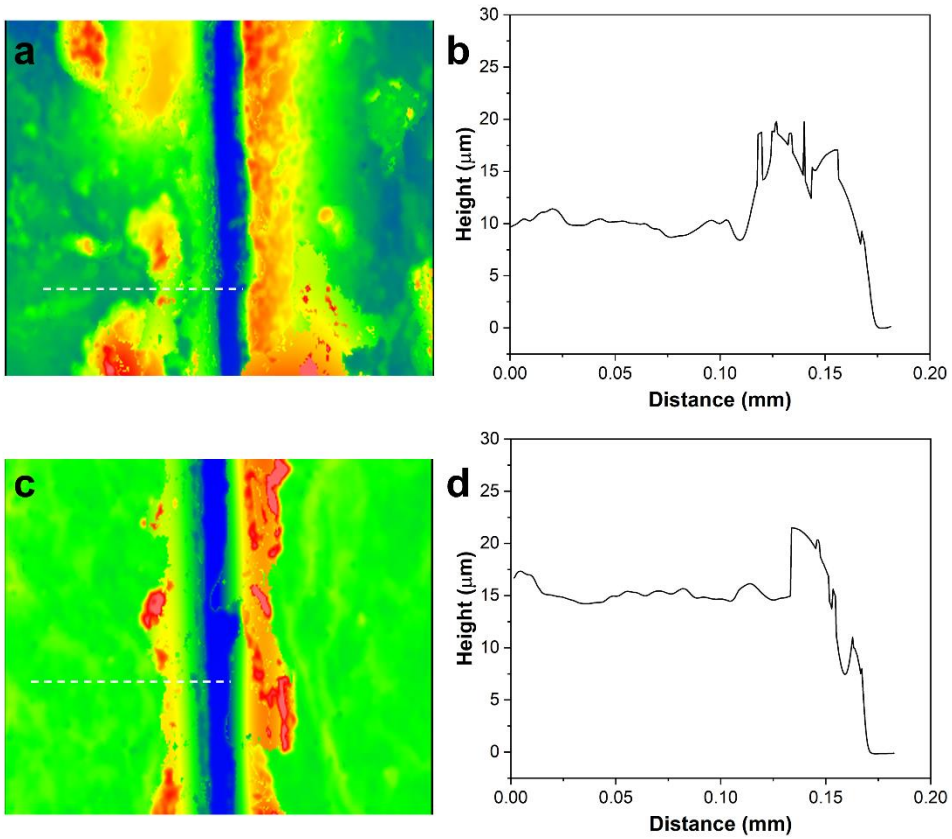

Figure S4. Optical profilometer image (a) and cross-section analysis (b) of G-TiO2 NS coating on silicon substrate. Optical profilometer image (c) and cross-section analysis (d) of G-TiO2 NS coating with GO primer layer on silicon substrate.

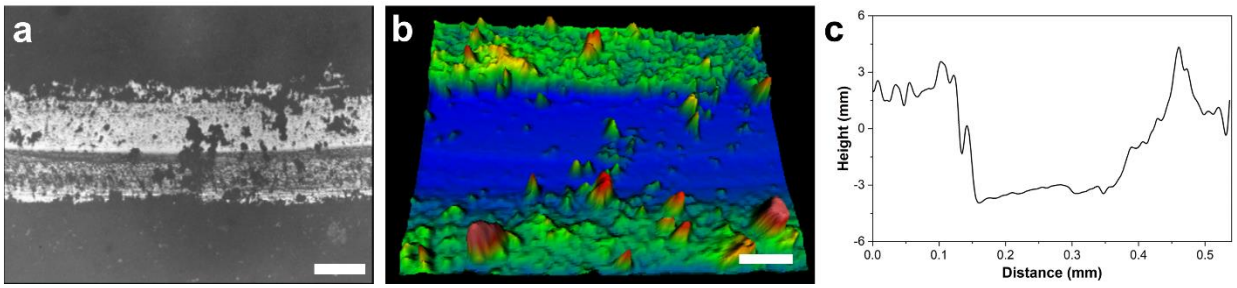

Figure S5. Wear track characterization of TiO_2 NPs coating. (a) Optical image, (b) corresponding 3D optical profile, and (c) cross-section height profile the wear track. All scale bars are 100 μm.

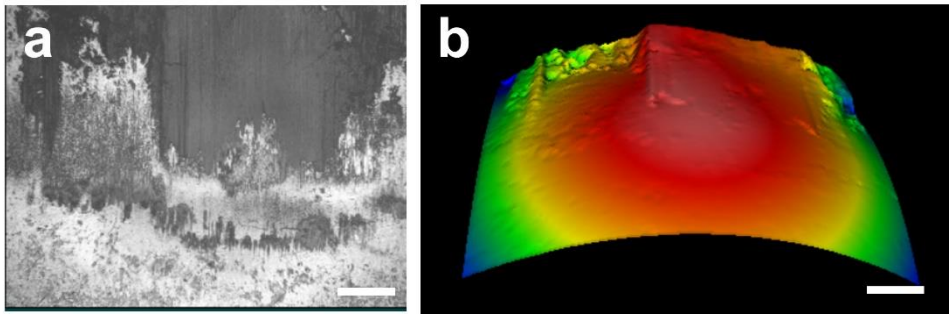

Figure S6. (a-b) Optical microscope image of the ball wear and the corresponding 3D optical profile image of the ball tested on G-TiO_2 NS with GO primer layer. All scale bars are 100 μm.

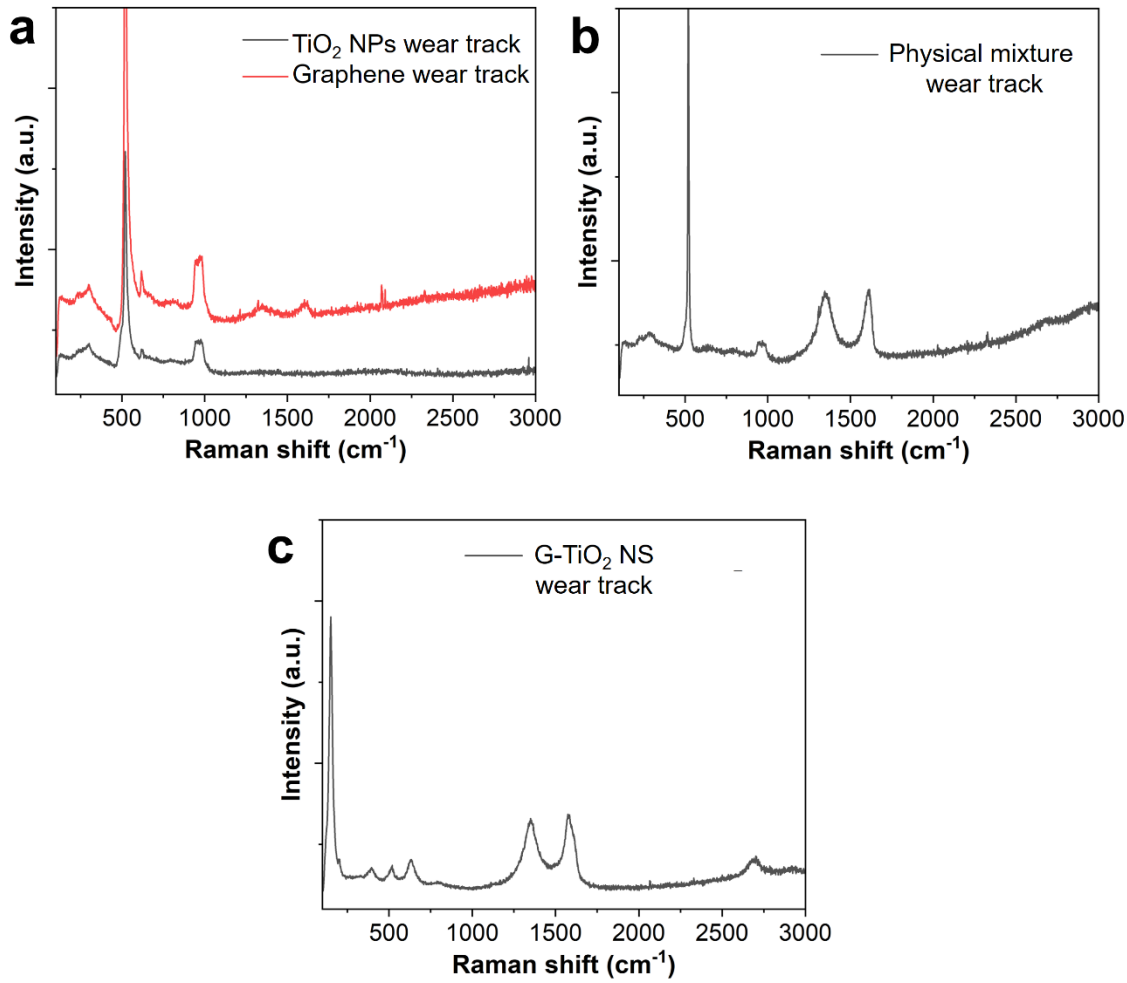

Figure S7. (a) Raman spectra of the wear tracks from TiO_2 NPs coating and graphene coating. (b) Raman spectrum of the wear track from physical mixture of graphene and TiO_2 NPs. (c) Raman spectrum of the wear track from G-TiO_2 NS.

Ball wear rate calculation

The wear volume (V) of the balls after tribology testing was estimated using the following equation.[1]

$$V = \left(\frac{\pi h}{6}\right)\left(\frac{3d^2}{4} + h^2\right) \quad (1)$$

Where d is scar diameter on the ball measured from optical microscope image, r is the radius of the ball and h is given by the following equation.

$$h = r - \sqrt{r^2 - \frac{d^2}{4}} \quad (2)$$

The Ball wear rate (K_B) can be calculated by using the wear volume (V), the applied load (W) and sliding distance (S) using the following equation:[2]

$$K_B = \frac{V}{S \times W} \quad (3)$$

References

(1) Mutyala, K. C.; Wu, Y. A.; Erdemir, A.; Sumant, A. V. Graphene-MoS2 Ensembles to Reduce Friction and Wear in DLC-Steel Contacts. *ACS Nano* **2019**, *146*, 524-527.