Supporting Information

DBHP functionalized ZnO nanoparticles with improved antioxidant properties as lubricant additives

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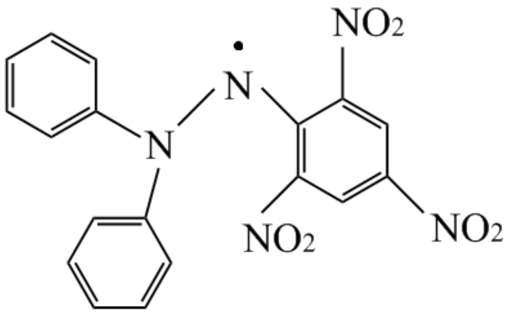

Figure S1. The structure of DPPH.

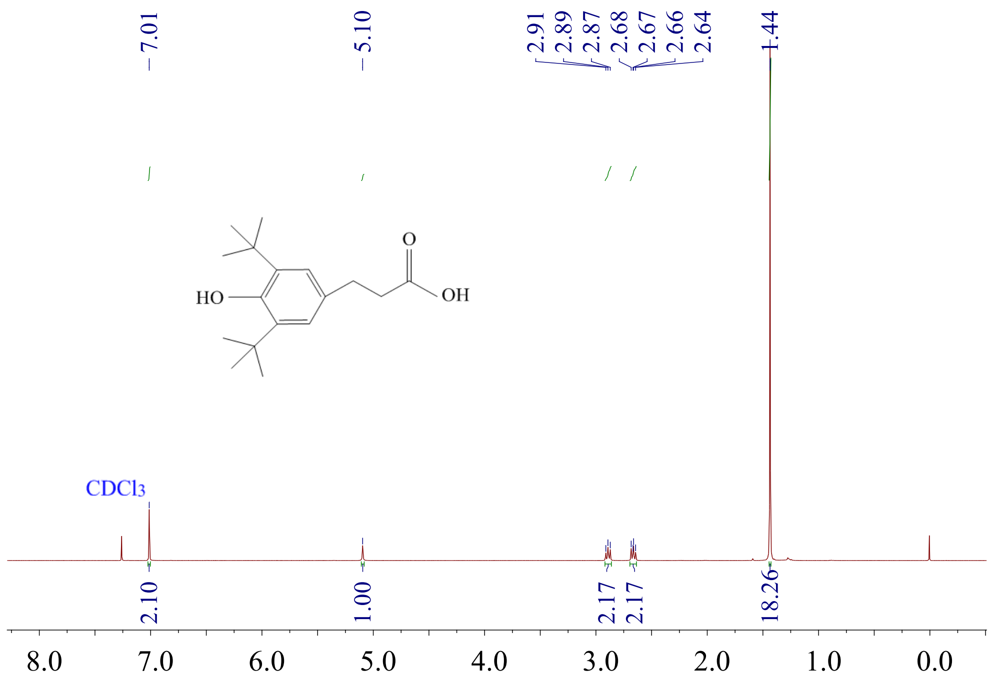

Figure S2. ^{1}H NMR spectrum of DBHP in $CDCl_3$.

^{1}H NMR (400 MHz, $CDCl_3$): δ 1.44 (s, 18H, $-CH_3$), 2.66 (t, 2H, $-CH_2$), 2.89 (t, 2H, $-CH_2$), 5.10 (s, 1H,-OH), 7.01 (s, 2H, -ArH).

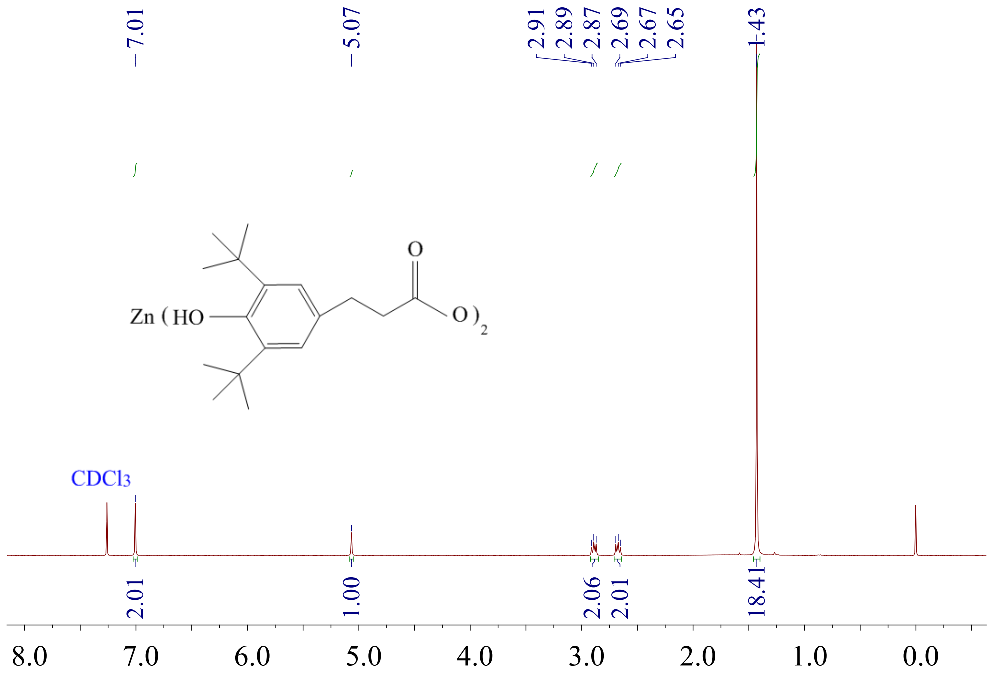

Figure S3. ^{1}H NMR spectrum of $Zn(DBHP)_2$ in $CDCl_3$.

^{1}H NMR (400 MHz, $CDCl_3$): δ 1.43 (s, 18H, $-CH_3$), 2.67 (t, 2H, $-CH_2$), 2.89 (t, 2H, $-CH_2$), 5.07 (s, 1H,-OH), 7.01 (s, 2H, -ArH).

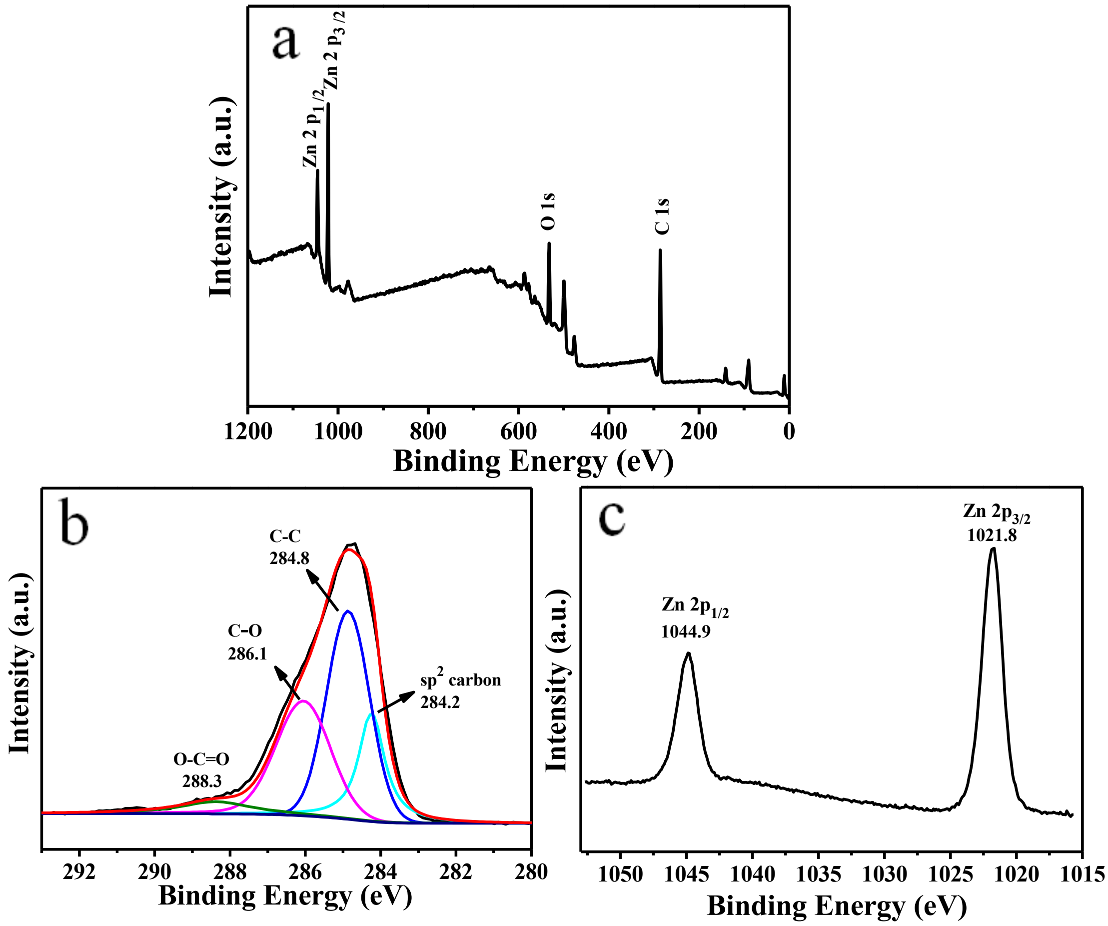

Figure S4. (a) XPS survey scan of DBHP-ZnO nanoparticles. (b) C1s spectrum and (c) Zn 2p spectrum.

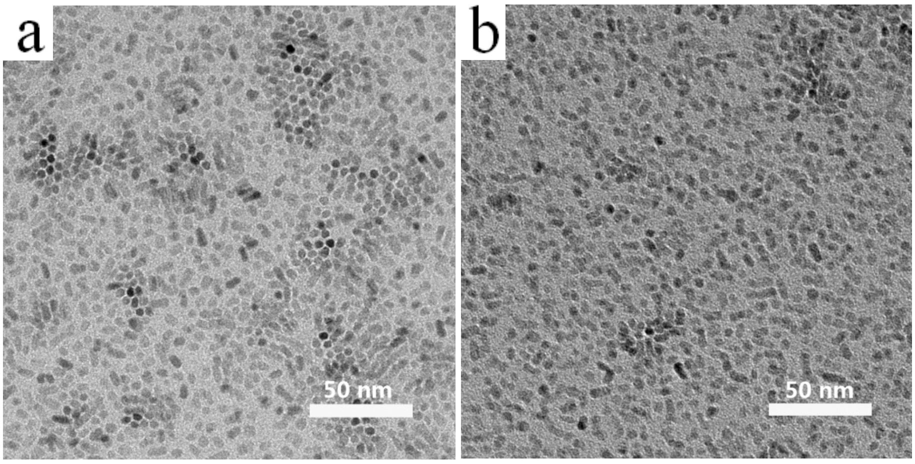

Figure S5. TEM images of DBHP-ZnO nanoparticles with the organic content of (a) 22% (b) 15%.

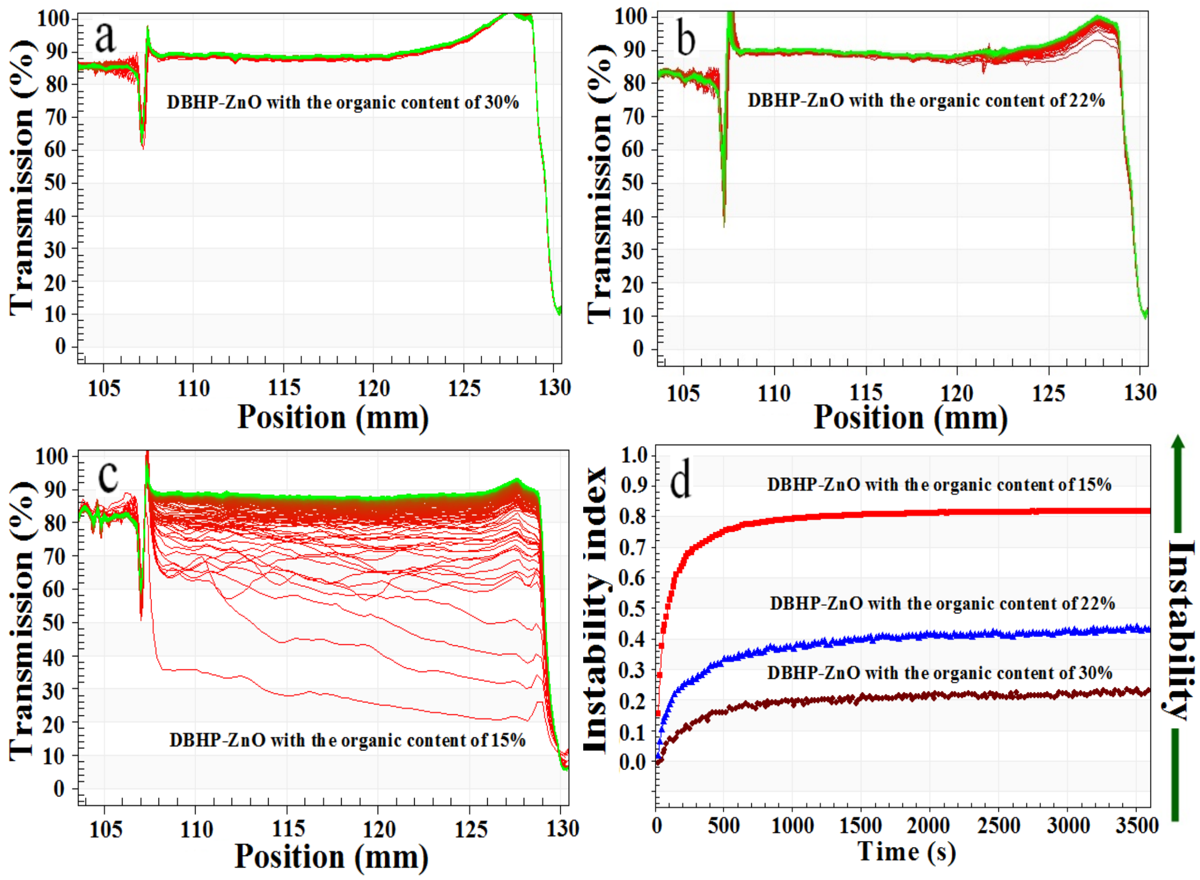

Figure S6. Transmission profiles of DBHP-ZnO nanoparticles with the organic content of 30% (a), 22% (b) and 15% (c) in DIOS. (d) Variations of instability index with time.

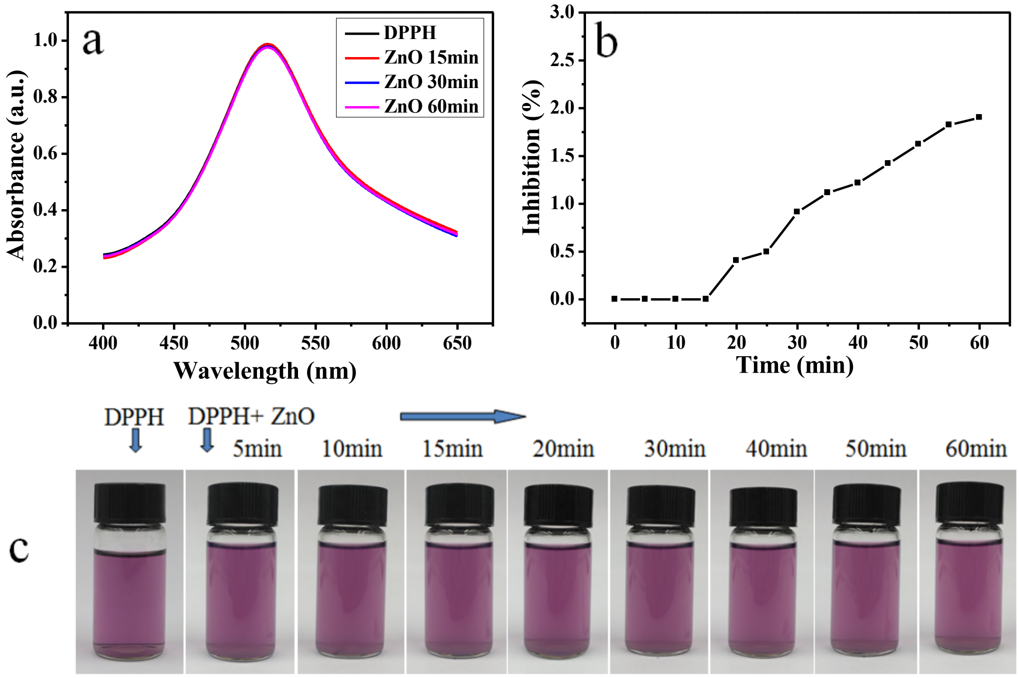

Figure S7 (a) UV-vis absorption spectra of the DPPH radicals with ZnO after different reaction periods. (b) Time dependent DPPH scavenging by ZnO. (c) Optical photographs of DPPH radicals reacting with ZnO after different durations.

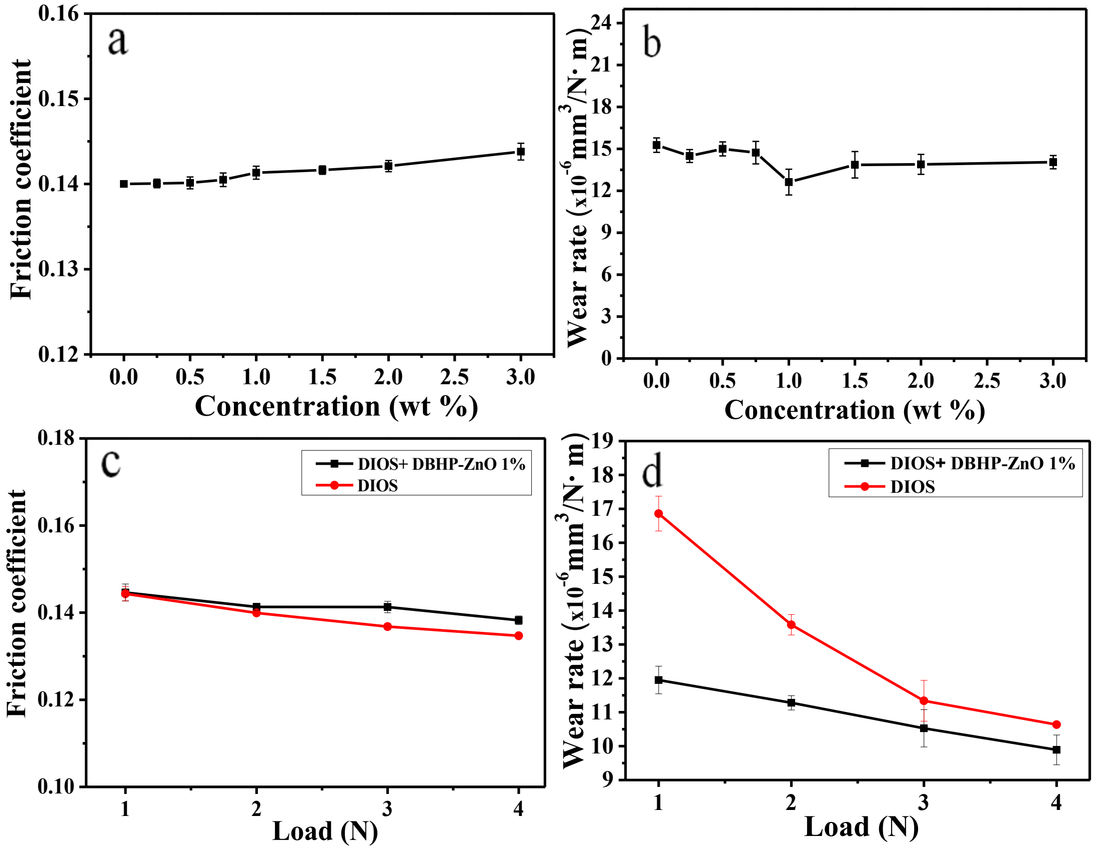

Figure S8. (a) Variations of friction coefficient and (b) wear rate with the concentration of DBHP-ZnO nanoparticles in DIOS. (c) Variations of friction coefficient and (d) wear rate with load.

Table S1. Onset decomposition temperature of several antioxidants.

Antioxidant	Onset decomposition temperature (°C)	Ref
Am1	212	(1)
Am2	225	(1)
BD	271	(2)
GM	185	(3)
AO	200	(4)
BHA	<100	(5)
BHT	<100	(5)
TBHQ	<100	(5)
PG	184	(5)
Gallic acid	68	(5)
Caffeic acid	170	(5)
Ferulic acid	147	(5)

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(5) Santos N. A.; Cordeiro A. M.; Damasceno S. S.; Aguiar R. T.; Rosenhaim R.; Filho J. R.; Santos I. M.; Maia A. S.; Souza A. G. Commercial antioxidants and thermal stability evaluations. *Fuel* **2012,** 97:638-643.