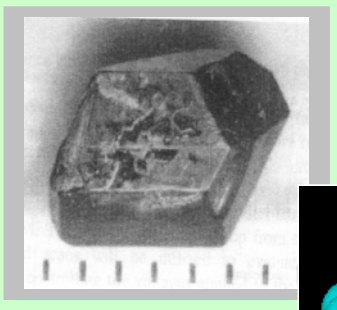
Nanotribology of Buckyballs

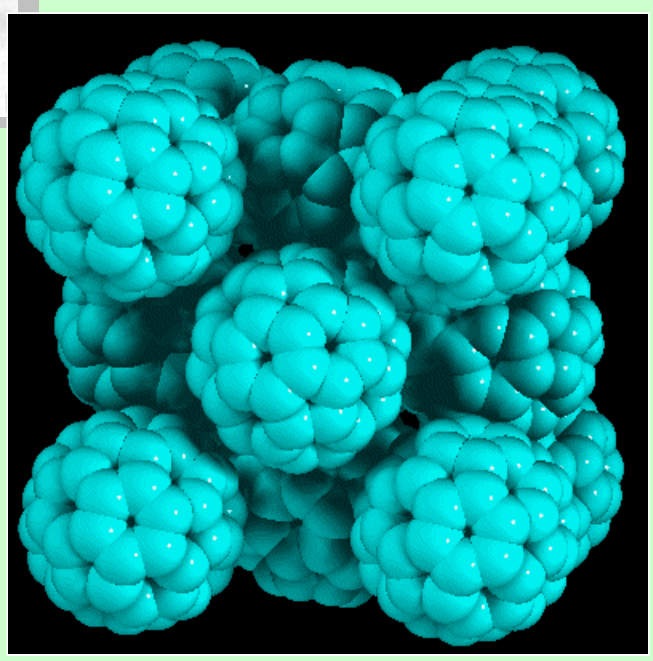
Qi Liang, O.K.C. Tsui, Yabo Xu, Hongnian Li and Xudong Xiao,
Phys. Rev. Lett. 90, art.146102 (2003)

Nanoscale ball bearings

Searching for energy dissipation channels is one of the main themes in nanotribology. Because of the nearly perfect spherical shape, C_{60} was speculated as molecular ball bearings and lubricants. Whether the rotation degree of freedom of C_{60} molecules contributes to energy dissipation is also of interest to many scientists in this field. We make use of the orientational order-disorder phase transition to study this problem.



Crystalline C_{60}



Above 260 K	Below 260 K
FCC structure	SC structure
All molecules rotate freely	Orientationally ordered
van der Waals force	+ electrostatic force
1.417 nm	1.404 nm

At 265K, crystalline C_{60} undergoes an order-disorder molecular orientational phase transition.

The free rotation above 265 K was found to reduce the adhesion force and thus the friction against AFM tips. However, the friction coefficient and thus the energy dissipation channel was found not affect by this rotation.