Resonant electron heating and molecular phonon cooling in single C_{60} junctions

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The functionality of single molecules as electronic devices relies on a good stability against large current densities. Electronic current generates heat in the molecular junction due to electron-vibration coupling and eventually leads to thermal decomposition of the molecule.

Using a scanning tunnelling microscope operated at 5 K, we investigate the electronic current and power to decompose single C_{60} molecules on different metal surfaces (Cu(110), Pb(111) and Au(111)). The power for decomposition results from the balance of heating and cooling efficiencies. The heating varies with electron energy and reflects the resonance structure participating in the transport. Cooling on the other hand is a non-resonant process, where molecular vibration quenching is dominated by their decay into electron-hole pair excitations in the metal substrate. Charge transfer into C_{60} upon adsorption on Cu(110) and on Pb(111) facilitates this cooling leading to a larger stability of the molecule than on Au(111). When the STM tip contacts the fullerene the molecule can sustain much larger currents due to the opening of an additional cooling reservoir.