Light at Ambient Temperature

The Kelvin-Planck statement of the second law of thermodynamics precludes the extraction of work from a single thermal reservoir. But the Kelvin-Planck statement may be circumvented by devising a heat engine to produce work from a single reservoir as the temperature of its working medium is spontaneously lowered to absolute zero.

One such heat engine uses a working medium of atoms on the surface of voids in a nanoporous solid. At ambient temperature, the atoms normally emit infrared (IR) radiation. The voids having inside dimensions (< 100 nm) are treated as quantum electrodynamics (QED) cavities having electromagnetic (EM) resonant frequencies beyond the ultraviolet (UV), and therefore the lower frequency IR radiation from surface atoms is suppressed in the higher UV resonant cavities. In a QED cavity, the suppressed IR loss may only be conserved by an equivalent gain at its resonant frequency, as all lower frequencies are inadmissible, and therefore coherent UV radiation is spontaneously produced in the surface atoms. By selecting the nanoporous material to be a fluorophore, the heat engine finds utility by the UV radiation exciting the surface atoms to emit coherent visible (VIS) light.

Because of the VIS light produced, the surface atom temperatures tend to absolute zero, but ambient temperature is recovered within 100 ps by conductive heat flow from the underlying solid material. Provided the radiative lifetime of the fluorophore is long compared to the 100 ps recovery time of the surface atoms, the heat engine produces VIS light by the continuous suppression of IR radiation. The VIS light from a single void is < 1 μW, but the collective light from the many voids may provide a practical light source, e.g., the VIS light from a 1 mm diameter of the nanoporous material may be comparable to the common 100 W light bulb. Since means may always be devised for the VIS light to lift a weight, the heat engine effectively extracts work from a single reservoir. But the Kelvin-Planck statement is not violated because the heat engine operates between the steady reservoir at ambient temperature and a momentary second reservoir at absolute zero.

Materials research is suggested in the development of nanoporous fluorophores having long radiative lifetimes and which are both VIS transparent and UV absorbent. If successful, the research offers the promise of a limitless VIS light source from the ambient without chemical or nuclear pollution. Although electricity is not directly produced, the VIS light source would reduce the burden on conventional power plants to produce electricity for artificial lighting, and thereby lessen the world dependency on foreign oil.