CO_2-Reduction Primary Cell for Use on Venus

NASA's Jet Propulsion Laboratory, Pasadena, California

A document proposes a CO_2-reduction primary electrochemical cell as a building block of batteries to supply electric power on the surface of Venus. The basic principle of the proposed cell is similar to that of terrestrial Zn-air batteries, the major differences being that (1) the anode metal would not be Zn and (2) CO_2, which is about 96.5 mole percent of the Venusian atmosphere, would be used, instead of O_2, as the source of oxygen. The cell would include a solid electrolyte that could withstand operation at a temperatures as high as 1,000 °C and, hence, could withstand operation at the Venusian surface temperature of ≈460 °C.

Electrical energy would be generated by a combination of (1) electrochemical reduction of CO_2 at the cathode and (2) oxidation of a suitable metal to metal oxide at the anode. Unlike some other types of cells that have been considered for use on Venus, the CO_2-reduction cell could operate for a long time, without need for cooling. If the anode metal were Mg, then the performance could be impressive: The specific energy of the proposed cell has been estimated theoretically to be 3.46 W·h/g.

This work was done by William West, Jay Whitacre, and Sekharipuram Narayanan of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-40892

Cold Atom Source Containing Multiple Magneto-Optical Traps

This source allows a smaller package relative to single-trap sources of similar performance.

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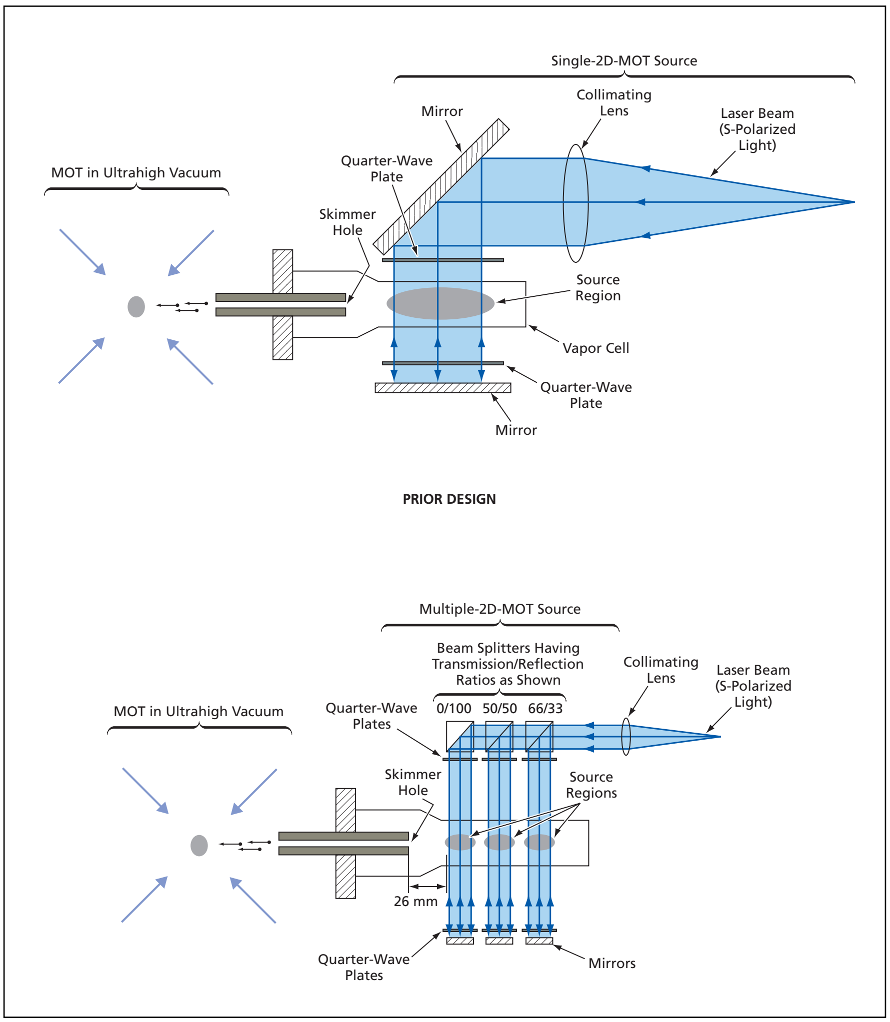
An apparatus that serves as a source of a cold beam of atoms contains multiple two-dimensional (2D) magneto-optical traps (MOTs). (Cold beams of atoms are used in atomic clocks and in diverse scientific experiments and applications.) The multiple-2D-MOT design of this cold atom source stands in contrast to single-2D-MOT designs of prior cold atom sources of the same type. The advantages afforded by the present design are that this apparatus is smaller than prior designs.

The figure schematically depicts a prior single-2D-MOT source and the present multiple-2D-MOT source. (It should be noted that the 2D nature of these sources lies in an aspect of the optics that has been omitted from the figure for the sake of simplicity. The plane of the figure corresponds to one of two planes of incidence. The other plane of incidence, perpendicular to the plane of the figure and coincident with the horizontal axis of the source region, contains a set of optics identical to those shown here.)

In the single-2D-MOT apparatus, a cell that is otherwise evacuated contains a vapor of atoms at a regulated low pressure. Slower atoms are collected in the source region by the magneto-optical trapping action. A cold beam of atoms leaves the trapping region by passing through a skimmer hole, along a graphite-getter-lined differential pumping tube, into an MOT in an ultrahigh vacuum wherein the atoms are utilized.



These **Simplified Schematic Diagrams** of two cold atom sources highlight some of the main differences between the single- and multiple-2D-MOT designs.

The present multiple-2D-MOT apparatus works similarly, except that multiple smaller 2D MOTs that form shorter source regions are concatenated to form the equivalent of a single longer 2D MOT source region. In each of the two planes of incidence, the multiple laser beams needed for the multiple traps are generated from a single input laser beam by use of a stack of beam splitters.

The advantages of compactness of the present design arise as follows: In the prior single-2D-MOT case, the overall linear dimensions of the optics and the laser beam equal or exceed the length of the source region. In the present multiple-2D-MOT case, the laser beams can be narrower and, hence, the optics can be smaller. One can, if necessary, create a longer source region for higher cold atom flux, without using wider laser beams and without widening the overall apparatus, by adding 2D MOTs and correspondingly modifying the optics to include more beam splitters.

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