

ELECTROLYTIC SMELTING OF LUNAR ROCK FOR OXYGEN, IRON, AND SILICON

Larry A. Haskin, Russell O. Colson, David J. Lindstrom, Robert H. Lewis, and Krystyna W. Semkow, Department of Earth and Planetary Sciences and McDonnell Center for the Space Sciences, Washington University, St. Louis MO 63130

ABSTRACT

Preliminary studies of the electrochemical properties of silicate melts such as those available from heating of lunar mare soils indicate that conductivities are high enough for design of a practical electrolytic cell. The nature and kinetics of the electrode reactions, which involve reduction of Fe^{2+} and Si(IV) and oxidation of silicate anions as the primary, product-forming reactions, are also satisfactory. A survey of the efficiencies for production (amount of product for a given current) of O_2 , Fe^0 , and Si^0 as functions of potential and of electrolyte composition indicate that conditions can be chosen to yield high production efficiencies. We also conclude that electronic conductivity does not occur to a significant extent. Based on these data, a cell with electrodes of 30 m^2 in area operating between 1 and 5 volts with a current between 1.6 and 3.5×10^5 amperes for a mean power requirement of 0.54 Mw and total energy use of ~ 13 Mw-hrs per 24-hour day would produce 1 tonne of O_2 , 0.64 tonnes of Fe^0 , 0.62 tonnes of Si^0 (as Fe^0 - Si^0 alloy), and about 2.5 tonnes of silicate melt of altered composition per 24 hours. Adjustable distance between electrodes could offer flexibility with respect to feedstock and power source.