9:30 a.m.
Laser Processing of Semiconductors:* *J. Narayan,* Solid State Division, Oak Ridge National Laboratory, Oak Ridge, TN 37830.

Pulsed ruby or Nd-YAG lasers (pulse duration 15-100 x 10^{-9} s) provide a controlled source of heat by which thin layers (<1μm) of metals or semiconductors can be rapidly melted and subsequently solidified with regrowth velocities exceeding one meter per second. These rates can be varied by controlling the sample temperature and laser parameters. Under these rapid solidification conditions, it has been found that there is a maximum in the solute concentration which could be incorporated into the substitutional sites, these values exceeded equilibrium solubility limits by factors up to 500. At still higher dopant concentration planar solid-liquid interface is no longer stable and it breaks into cellular structures. The laser-melt quenching can be used to manipulate microstructures and hence to obtain unique physical properties of materials.

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*Research sponsored by the Division of Materials Sciences, U. S. Department of Energy under contract W-7405-eng-26 with Union Carbide Corporation.

10:00-10:10 a.m. — Break

10:10 a.m.
Heat Flow During CW Laser Materials Processing: *J. Mazumder,* University of Illinois at Urbana-Champaign, Department of Mechanical and Industrial Engineering, 144 Mechanical Engineering Building, Urbana, IL 61801, W. M. Steen, Dept. of Metallurgy & Materials Science, Imperial College of Science & Technology, London, England.

A three dimensional heat transfer model for laser materials processing with a moving Gausian heat source is developed using finite difference numerical techniques. Heat losses by re-radiation and convection from both the upper and lower surfaces are considered. The system is assumed to be in a quasi-steady-state condition after the "keyhole" initiation period which for most practical purposes may be considered instantaneous. Heat transfer models reported in existing literature is reviewed and compared with this model together with comparisons between the model predictions and experiments in laser welding, laser arc augmented welding, laser surface treatment, and laser glazing.

10:40 a.m.
Optical Properties of Metal Surfaces: *W. T. Walter,* Department of Electrical Engineering, Microwave Research Institute, Polytechnic Institute of New York, Route 110, Fermindale, NY 11735.

ABSTRACT NOT AVAILABLE

11:10 a.m.
Thermal Coupling of CO_2 Laser Radiation to Metals: *C. T. Walters,* T. R. Tucker, S. L. Ream, and A. H. Clauer, Battelle Columbus Laboratories, 505 King Avenue, Columbus, OH 43210.

Basic mechanisms operative in the interaction of CO_2 laser beams with metals will be reviewed from the point of view of applications of these beams to metal processing problems. Thermal coupling data for metals having various conditions of surface preparation will be presented. Results of both continuous and pulsed laser beam interactions and the effects of beam intensity will be discussed.

11:40 a.m.
Modelling of Rapid Surface Melting and Resolidification: J. A. Sekhar, Dept. of Metallurgy & Mining Engrg., University of Illinois, Urbana, IL, and R. Mehrabian, Metallurgy Division, National Bureau of Standards, Washington, D.C. 20234.

LIQUID MEMBRANES AND SOLVENT EXTRACTION

Sponsored by the Joint TMS/SME Hydrometallurgy/ Chemical Processing Committee

Tuesday, February 24, 1981 **Michigan/Michigan State Room**
8:30 a.m. **Chicago Marriott Hotel**

Session Chairperson: K. Osseo-Asare, Dept. of Materials Science & Engineering, The Pennsylvania State University, University Park, PA 16802.
G. A. Kordosky, Henkel Corp., 1844 West Grant Road, Tucson, AZ 85705.

8:30 a.m.
Metal Extraction by Liquid Membrane: R. P. Cahn, J. W. Frankenfeld and *N.N. Li,* Exxon Research & Engineering, P.O. Box 45, Linden, NJ 07036; D. Naden, Davy-McKee Co., R&D Dept., Stockton-on-Tee, U.K.; K.N. Subramanian, Exxon Minerals Co., Forham Park, NJ 07932.

Important variables governing the permeation of metal ion through liquid membranes and their effects on the separation process were described. These variables include acid concentration, emulsion "swell", membrane viscosity, treat ratio (volume ratio of emulsion to feed in mixer), complexing agent concentration, internal droplet size, internal phase leakage and copper concentration in the internal phase. The information is needed for scaling-up of equipment and further process development. The economic evaluation based on bench-scale pilot plant runs shows this process is 40% cheaper than solvent extraction for copper extraction.

9:00 a.m.
Coupled Transport Membranes for Metal Separations: *W. C. Babcock,* R. W. Baker and H. K. Lonsdale, Bend Research, Inc., 64550 Research Road, Bend, OR 97701.

A new process for separating and concentrating metals is described. It is based on the principle of coupled transport. Metal ions can be "chemically pumped" across a membrane against large concentration gradients by coupling the metal ion flow to the flow of another ion. The process relies on a microporous membrane containing within its pores an organic, water immiscible complexing agent. This agent acts as a shuttle, picking up metal ions on one side of the membrane, carrying them across the membrane as a complex, and preserving electrical neutrality by carrying ions of the same charge in the opposite direction or ions of the opposite charge in the same direction. The energy for chemically pumping metal ions "uphill", against their concentration gradient, is derived from the flow of the coupled ions down their concentration gradient. The process has been demonstrated for several metals currently recovered via hydrometallurgical techniques. The process could therefore find application in the recovery of these metals from dilute leach solutions.

9:30 a.m.
Liquid Membrane Metal Extraction Process for Recovering Copper from Mine Water: *Ralph W. M. Lai,* Kennecott Minerals Co., Salt Lake City, UT 84147.

Bench-scale exploratory extraction and stripping experiments are reported in which copper was extracted from synthetic minewater into a liquid membrane emulsion, which was subsequently stripped with tankhouse electrolyte for copper electrowinning.

The encapsulated phase in the emulsions was an acid solution of copper sulfate. The continuous phase (the "liquid membrane") was LIX 64N* dissolved in an organic Exxon-proprietary solvent which also contained proprietary surfactants and stabilizers.

Both batch and continuous planned experiments were run over a wide range of all manipulable variables. Test results were correlated by multiple regression and plotted on contour maps. Optimal flowsheets were developed for 0.5 gpl Cu minewater and >90% copper recovery.

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* General Mills Chemical, Inc. trademark

10:00 a.m.
Poroplastic® Bound Liquid Membranes for Hydrometallurgical Separations: *A. S. Obermayer* and L. D. Nichols, Moleculon Research Corporation, 139 Main St., Cambridge, MA 02142.

This paper will describe the use of Poroplastic® bound liquid membranes for use in hydrometallurgical processing of mineral ore. The approach concentrates and separates specific components from aqueous solution by extracting them into membranes loaded with organic liquids and then re-extracting them on the other side of the membrane into an aqueous stripping solution. The physical chemistry of the system is similar to a liquid-liquid extraction process, but the engineering design is more like the plate-and-frame and spiral wound modules used for reverse osmosis water desalination. Data will be presented on the recovery of cobalt from ammoniacal leach solution containing both cobalt and nickel salts derived from lateritic mineral ores. The process is economically attractive because of low operating costs and low capital investment, and it has the additional advantages of being convenient to use, energy saving, and adaptable to small scale operations.

10:30 a.m.
Chemical Properties of LIX63 in Mixed LIX65N/LIX63 Extraction Systems:* *M. E. Keeney* and K. Osseo-Asare, Dept. of Materials Science and Engineering, The Pennsylvania State University, University Park, PA 16802.

The mechanism of the catalytic behavior of LIX63 in mixed aliphatic/aromatic hydroxyoxime extraction systems has received consid-