



McGregor Center, Wayne State University

Refractory

Metals

à la Detroit

Ultramodern McGregor Center on the Wayne State University Campus, Detroit, was filled to near capacity by refractory metallurgists May 25-26. Reason: a symposium on Refractory Metals and Alloys, sponsored by the Institute of Metals Division and the Detroit section of AIME.

Julius J. Harwood, Chairman of the IMD Refractory Metals Committee, greeted the 400 metallurgists with an introduction to the *state of the art* of refractory metals—a subject which was thoroughly explored in the course of the two-day meeting. At the same time, he announced that there would be no recorded discussion, but that written discussion was invited for the meeting's proceedings volume.

Leading off the first session was William Rostoker of Armour Research Foundation. Dr. Rostoker spoke on *Phase Equilibria in Refractory Metal Systems*. He noted that a phase equilibria program should prescribe limited effort to maximum utilization. Included in the paper was a method for pinpointing troubles encountered in the use of various compounds at elevated temperatures.

Mechanical Behavior of Refractory Metals and Alloys delivered by James Bechtold, Westinghouse Electric Corp., was an assimilation of the literature on the mechanical behavior of refractory metals. Co-authors were E. Wessel and L. France, also of Westinghouse. The paper elicited much pencil pushing and even clicks of several cameras in the audience when the diagrams were flashed on the screen.

Strengthening of Refractory Alloys by W. H. Chang, Flight Propulsion Laboratory dept., General Electric Co., represented the third of the basic papers which served as an introduction to the subject.

Now there was a break for lunch, and the 200 who were lucky enough to get luncheon tickets settled down to some socializing and victuals. Later, it was back to the airy, acoustically-excellent auditorium for resumption of activities. But before the technical tempest was continued, AIME President, Joseph L. Gillson was introduced. Dr. Gillson welcomed those present and commented on the merits of AIME membership.

Next to operate the light pointer from the lectern was N. E. Promisel, Director, Materials div., Bureau of Naval Weapons, Dept. of the Navy. "Contrary to custom," Mr. Promisel explained, "I will begin by showing a slide." In just that light and informative vein did he describe AGARD, the Advisory Group for Aeronautical Research Development. Mr. Promisel pointed out that the Group functions under the North Atlantic Treaty Organization (NATO), and that two high-priority materials problems faced by NATO countries concern refractory metals and graphite.

More ponderous after-luncheon fare was served up in a paper by J. W. Semmel, Jr., Flight Propulsion Laboratory dept., General Electric Co. in *Oxidation Behavior of Refractory Metals and Alloys*, Mr. Semmel noted that improved oxidation-resistance has been obtained in potentially-useful alloys of all the base metals, except molybdenum. However, the oxidation resistance of alloys is still below that required for general purposes. Chromium alloys appear most promising, in view of the progress made in decreasing nitrogen absorption.

Edward Fox and J. A. McGurty, Aircraft Nuclear

Propulsion dept., General Electric Co., authored the fifth paper on the program, entitled *Chromium and its Alloys*. Another treatment of the topic was given by Robert Widmer, now technical director, New England Materials Laboratory. Toru Yukawa, formerly a research asst., Massachusetts Institute of Technology and N. J. Grant, professor of metallurgy, MIT, were the co-authors of *Oxidation Behavior of Chromium-Base Alloys at Temperatures Between 1800° and 2200°F*.

Next to be heard was Fred J. Anders, Jr., E.I. du Pont de Nemours & Co. Inc. *Metallurgy of Columbium and Its Alloys* was the subject of his talk. *The Present and Future of Columbium Alloys* by R. G. Frank, Flight Propulsion Laboratory dept., General Electric Co., described making usable hardware from columbium. There was time for a little discussion following the second of the columbium papers and both authors were questioned.

Paper No. 9 was *Molybdenum and Its Alloys* by M. Semchyshen and R. Q. Barr, Research Laboratory, Climax Molybdenum Co. of Michigan. Mr. Semchyshen was also Chairman of the Detroit section, AIME Host Committee, and to him should go accolades for diligence in seeing that the authors did not violate their limits too fragrantly.

Thus ended the first day of technical papers. Registrants soon retired to the social hour which was sponsored by the Detroit section, and then went on to other social pursuits.

Second day

Tungsten and Tungsten Base Alloys led off the final day's activities. The paper was authored by R. Atkinson and R. C. Koo, Research Laboratories, Westinghouse Lamp div.; Mr. Atkinson delivered the paper. Sigmund Weissmann, Rutgers University next delivered a discussion based on his X-ray studies of tungsten.

Tantalum and Tantalum Alloys was the subject of a paper by A. B. Michael, Fansteel Metallurgical Corp. It was both an historical analysis and a review of tantalum and its alloys.

Now it was time out for a coffee break, and when the majority could again be corralled in the auditorium, R. I. Jaffee of Battelle Memorial Institute delivered a paper on *Rhenium and the Refractory Platinum-Group Metals*. Co-authors were D. J. Maykuth and R. W. Douglass of Battelle. These metals are relatively easy to produce in high-purity form, explained Dr. Jaffee, but they pose difficulties in fabrication, the difficulty increasing in the following order: rhodium, iridium, rhenium, ruthenium, and osmium. Low-temperature ductility problems are encountered, particularly in iridium, ruthenium, and osmium. In fact, it was pointed out, osmium has yet to be successfully fabricated. As to oxidation resistance, it ranges from poor for rhenium, osmium, and ruthenium, to the best of any known metal for rhodium. In regard to alloying effects of rhenium in group VI_A metals (Cr, Mo, W), investigation indicates that the refractory platinum-group metals possess many, but not all, of these characteristics.

The last paper presented before the luncheon break was *High Temperature (2000°F) Strength Properties of Refractory Metals and Alloys*. R. W. Hall, Lewis Research Center, National Aeronautics and Space Administration, delivered the paper. Co-workers, P. F. Kikora and G. Mervin Ault helped with the research and paper.

The last session

Back to work after lunch, but with some lighter after-lunch fare. Chairman Harwood read his translation from the French of Robert Syre's paper, *Survey of European Development in Refractory Metals*. Mr. Syre, of the French firm, Pechiney, was unable to attend.

Fabrication and Processing of Refractory Metals was next on the agenda, with C. P. Mueller, Refractomet div., Universal-Cyclops Steel Corp., doing the honors. Mr. Mueller described work on two systems: molybdenum-titanium and molybdenum-columbium. His slides on application of refractory metal sheet in air frames and other hardware provoked much picture snapping from the audience. And his predictions on the revolutionary era which refractory metals are approaching stimulated no little amount of interest. Equipment developments, Mr. Mueller says will make this possible. And the machinery and material on which he bases this prediction is, in part, Cyclops' own InFab (Inert Fabrication) facility. This inert argon atmosphere room, impactor, rolling mill, and furnaces were described in the August issue of *Journal of Metals*, p. 636.

The last paper on the schedule was *Protective Coatings for High Temperature Environments*. E. D. Sayre, Flight Propulsion Laboratory Dept., General Electric Co., representing his co-authors, L. Luft and J. Graham, read the paper.

Mr. Sayre outlined the criteria for coatings needed to protect refractory metals against oxygen and nitrogen diffusion. Also included in the well-organized paper were some results on development of protective coatings for molybdenum and columbium used at 2500°F. The plots on the graphs precipitated much neck craning by the audience.

It was now 2:50 pm, and the meeting which had started out in arrears time-wise was now ahead of schedule. Thus, more time was allowed a choice panel of experts to consider refractory metal applications. Moderating the panel on the Comparative Status of Refractory Metals for Engineering Applications was W. J. Harris, Jr., executive director, Materials Advisory Board, National Academy of Sciences. Dr. Harris also is an AIME Director from the Institute of Metals Division. Sitting on the panel were E. Czarnecki, Boeing Aircraft Co.; G. M. Ault, Lewis Research Center, NASA; R. A. Perkins, Solid Rocket Plant, Aerojet-General Corp.; A. V. Levy, Aircraft div., Hughes Tool Co.; and P. Patriarca, Oak Ridge National Laboratory.

Mr. Czarnecki tackled the application of refractory metals from the standpoint of advanced, weapon systems; Mr. Ault's area was space vehicles; Mr. Perkins on missiles; Mr. Levy on ramjets; and Mr. Patriarca on nuclear applications. Each of them explained the part played by refractory metals in his own space-age application. Then it was time for questions from the audience, and questions were forthcoming from the too-long silenced onlookers. The differing partialities of the panelists prompted a stimulating discussion of the relative merits and demerits of columbium, molybdenum, and tungsten for defense purposes.

Their tongues loosened and their interests satiated after two days jam-packed with of technical papers, the 400 metallurgists once again turned to the highways and byways . . . with perhaps a little more knowledge that could help them in their jobs.

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