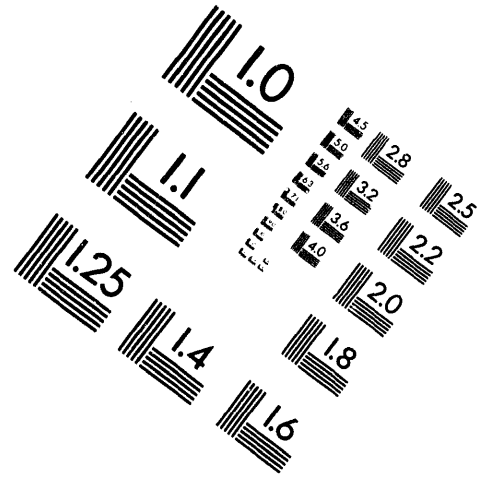
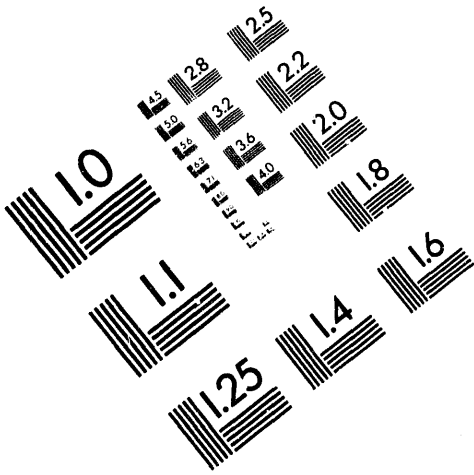




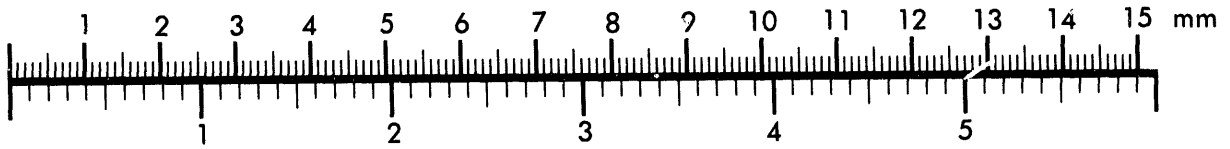
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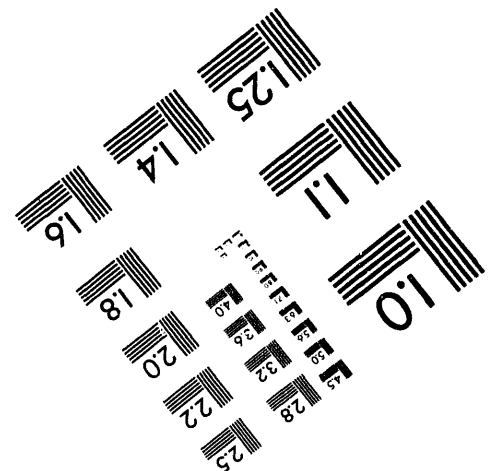
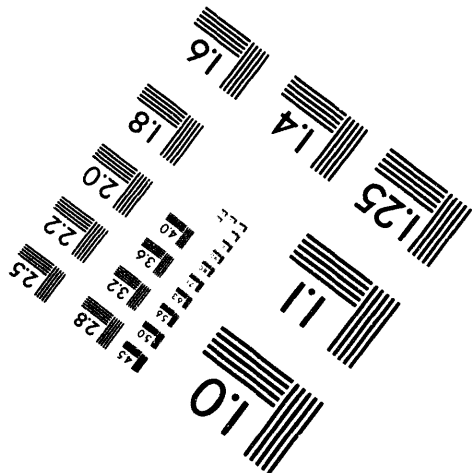
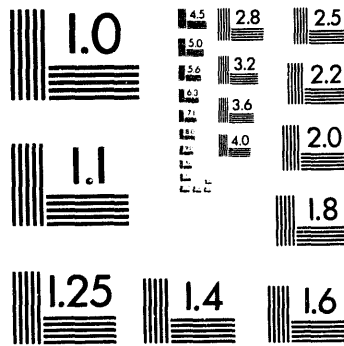
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LITHIUM FERRATE AND LITHIUM COBALTATE CATHODES FOR MOLTEN CARBONATE FUEL CELLS

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Lithium Ferrate and Lithium Cobaltate Cathodes for Molten Carbonate Fuel Cells

CONTRACT INFORMATION

Contract Number 49946

Contractor Argonne National Laboratory
9700 S. Cass Avenue
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Contractor Project Manager Kevin M. Myles

Principal Investigators Michael Krumpelt and Michael F. Roche

Co-Investigators Ira D. Bloom, J. Ernesto Indacochea, and
Gene H. Kucera

METC Project Manager Bruce Harrington

Period of Performance October 1, 1982 to Open

OBJECTIVE

The objective of this research is to develop cathodes for the molten carbonate fuel cell (MCFC) having a performance approaching that of the lithiated nickel oxide cathode and a significantly greater life, particularly in pressurized MCFCs. To meet this objective, cathodes containing either doubly doped lithium ferrate or lithium cobaltate are being developed.

BACKGROUND INFORMATION

The use of dopants such as Co, Ni, Mn, and Cu to improve the electronic conductivity of lithium ferrate cathodes for MCFCs was first described in a patent assigned to ANL investigators (1). This patent also included the use of lithium cobaltate as an MCFC cathode.

Subsequently, measurements were conducted to determine the properties of singly doped lithium ferrate cathodes under a broad range of MCFC operating conditions (2). These measurements showed that cobalt-doped lithium ferrate was the best of the singly doped lithium ferrate cathodes, but it only performed well over a very narrow range of MCFC cathode gas compositions. Our research then focused on the use of two dopants in

lithium ferrate cathodes (3). This doubly doped lithium ferrate cathode now has a performance approaching that of the lithiated nickel oxide cathode.

In addition, we have continued to investigate the lithium cobaltate cathode. Its performance also approaches that of the lithiated nickel oxide cathode. Others (4) have also been investigating the lithium cobaltate cathode and have shown that it exhibits a performance approaching that of the lithiated nickel oxide cathode.

PROJECT DESCRIPTION

This project is one of four MCFC projects that are being pursued at Argonne National Laboratory. The other three projects are described elsewhere in these proceedings. In this project, we are optimizing the composition, microstructure, and loading density of the doubly doped lithium ferrate cathode and the lithium cobaltate cathode.

Experiments in this project include measurements of the resistivities, Seebeck coefficients, and microstructures of the doubly doped lithium ferrate cathode and lithium cobaltate cathode. In addition, their performance in MCFCs is being determined,

and post-test analyses on the MCFCs are being conducted.

This project is linked to another project (development of an MCFC with high power density) because such MCFCs will require a cathode having a longer life than the present cathode, lithiated nickel oxide.

RESULTS

Molten carbonate fuel cells with either doubly doped lithium ferrate or lithium cobaltate cathodes now exhibit a voltage of 915 mV at 1600 A/m² when employing a cathode gas (58 mol% O₂-42 mol% CO₂) that simulates operation at 3-4 atm with standard oxidant (air plus 27 vol% CO₂). Under the same conditions, the voltage of an MCFC employing the lithiated nickel oxide cathode is 950 mV. The voltages of MCFCs employing doubly doped lithium ferrate and lithium cobaltate cathodes will be increased to 950 mV at 1600 A/m² by further cathode optimization. For example, studies are underway to determine the effects of increasing the cathode loading densities from their present value (about 100 mg/cm²) to the loading density currently being employed with the lithiated nickel oxide cathode (150 mg/cm²).

The lithium cobaltate cathode, like the lithiated nickel oxide cathode, required no special doping to achieve a high performance because its resistivity was low (1 Ω-cm vs 0.1 Ω-cm for lithiated NiO). Double doping was required to achieve an equivalent resistivity and performance from the lithium ferrate cathode. Cell tests of about 2000 h at high oxygen and carbon dioxide pressures have indicated the potential for long life in MCFCs having cathodes prepared from either doubly doped lithium ferrate or lithium cobaltate.

FUTURE WORK

Future experiments will be directed toward a detailed comparison of the relative performance, life, and life-cycle cost of the doubly doped lithium ferrate, lithium cobaltate, and lithiated nickel oxide cathodes in pressurized MCFCs. These experiments will be conducted by Argonne

National Laboratory and an industrial partner.

ACKNOWLEDGMENTS

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