

CRADA Final Report
CRADA No. BG98-221(01)

1. Parties:
Lawrence Berkeley National Laboratory and Hy-Tech Research Corporation
2. Title of the Project:
"Boron Carbide Coatings for Enhanced Performance of Radio-Frequency Antennas in Magnetic Fusion Energy Devices"
3. Summary of the specific research and project accomplishments:
(Were the goals of the CRADA achieved? Include relevant information but do not include proprietary or protected CRADA information.)
The purpose of this DOE STTR program was to develop a commercially scalable and economic method for depositing dense boron carbide films. The proposed method was based on cathodic arc deposition, which is well accepted as an economic way to deposit metal-based coatings. Cathodic arcs produce highly ionized plasmas, and the energy of the depositing species is controlled by applying a bias voltage to the substrate. This project extended this technology to non-metal boron-based cathodes.

A prototype deposition system consisting of a cathodic arc source with a heated cathode and the arc power supply was developed by Hy-Tech Research with the support of LBNL and Oak Ridge National Laboratory. LBNL role focussed on assisting component design and film deposition/characterization, and ORNL focussed on supplying the sintered boron carbides to be used as cathodes.

A few boron carbide films were produced, characterized and tested during the course of this investigation.

4. Deliverables:

Deliverable Achieved	Party (LBNL, Participant, Both)	Delivered to Other Party?
Technical advise for arc source development	LBNL	Y
Thin film deposition using LBNL deposition system	LBNL	Y
Provide cathode to Hy-Tech and LBNL	ORNL	Y
Thin film deposition using Hy-Tech deposition system	HT	Y
Characterization of film properties	LBNL	Y

5. Identify publications or presentations at conferences directly related to the CRADA?
 - a. "Boron Carbide Coatings for Fusion Plasma Facing Components" *Fusion Technology*, **39** (2), 910-915 (2001)
 - b. "Boron Carbide Films Prepared by Cathodic Arc Deposition" submitted *Journal of Materials Science* 2002
 - c. "Vacuum arc deposition of boron carbide", presented at the International Conference on Metallurgical Coatings and Thin Films 2000

6. List of Subject Inventions and software developed under the CRADA:
none

7. A final abstract suitable for public release:
This DOE STTR aimed at the development of a commercially viable method for the deposition of boron carbide for RF antennas. Boron carbide is composed of light (low-Z) elements and therefore its sputtering by-products are not damaging to the performance of magnetic fusion devices. In this Phase II, a prototype scale cathodic arc with a heated cathode was developed to deposit boron carbide. Films were prepared on test substrate and characterized by transmission electron microscopy, X-ray diffraction, Rutherford backscattering spectroscopy and electron energy loss spectroscopy.

8. Benefits to DOE, LBNL, Participant and/or the U.S. economy.
The Participant now has a unique cathodic arc source, and is attempting to expand its application to more commercial applications. The source is unique in the sense of using a heated cathode, and is suitable for forming plasmas from semiconductors or semimetals. In addition to the Magnetic Fusion application, Hy-Tech is pursuing application in the areas of tribology (with Boron and its compounds) and optical coatings (with Silicon).

9. Financial Contributions to the CRADA:

DOE Funding to LBNL	\$
Participant Funding to LBNL	\$ 150,000.00
Participant In-Kind Contribution Value	\$
Total of all Contributions	\$

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