Boron and Boron-Carbide Coatings as Deposited by the Cathodic Arc Technique*,
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Boron and boron based coatings potentially have great merit for many applications, but are difficult to deposit for reasons that are, in part, related to the favorable properties of the base material itself, boron. As a low-Z material, B is difficult to sputter and as a refractory material, it is difficult to evaporate. Feed gases of B, suitable perhaps for chemical vapor deposition, are expensive and dangerous. Therefore, the present effort has been dedicated to development of the cathodic arc technique for deposition of boron based coatings. In principle, the cathodic arc, also known as the vacuum arc technique, provides the highest deposition rates of any plasma deposition method for any case where the cathode material has suitable integrity. In the case of B, cathodic arc would appear to be the only viable technique for most applications. The present program is related to an earlier program at Oak Ridge National Laboratory, which produced films both by magnetron sputtering and by evaporation into an electron cyclotron resonance (ECR) microwave generated plasma. Deposition rates were low, but pertinent data on properties of films from that program will be presented.

The original motivation for development of the boron carbide coating was for use as an anti-erosion coating for RF antennas in fusion energy plasmas. However, since B_4C is well known as an industrial hard material, it can be expected that the coating will find other applications. The potential of essentially elemental boron, itself, as a coating may be less well-recognized because of previous difficulty in synthesis and fabrication of the material. In fact, however, B has a hardness value (33 GPa), which considerably exceeds that of practically all well-known industrial hard materials, including boron carbide, silicon carbide, aluminum oxide, tungsten carbide, and silicon nitride. This high hardness is available in the elemental and amorphous material, for which stoichiometry, grain size, orientation dependent growth rates and epitaxy are not expected to be parameters in coating deposition or performance. Although hardness is dependent on concentration of gaseous impurities, which may be derived from the residual vacuum, films with hardness values equal to that mentioned above have been produced. The high deposition rates associated with arc deposition are an advantage in overcoming effects of residual vacuum.

Boron has other properties that commend it as a possible alternative to hard chromium. As with chromium, corrosion protection is by oxide passivation, and the softness and lubriciousness of the oxide in relation to the hardness of the substrate is expected to result in resistance to galling and controlled wear characteristics. Superior hardness, refractory, combustion, and inertial properties have been mentioned. Moreover, as a reactive element, boron is expected to bond well with many substrates.

The presentation will further discuss progress, advantages, disadvantages, and possible applications for the coatings.

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