Microstructural analysis has played, and continues to play, a key role in the development of thermally sprayed coatings. The advances in equipment and consumable technology for evaluating coatings have enabled laboratory personnel to accurately observe the coating characteristics in a cost effective manner and with great confidence. Microstructural analysis has been important in the development of new thermally sprayed coatings used for aerospace, automotive, electronic, bio-technology, petroleum and other high and low tech applications. The coatings that are being developed consist of a combination of materials that vary in hardness and general microstructural characteristics. Accurate microstructural analysis is more important than ever because these new, complex coatings cannot be produced successfully without control of the microstructure. Established metallographic techniques have not always been able to produce accurate results. A resin bonded diamond surface was developed which reduces the damage created during the grinding and lapping of a variety of coating types while maintaining the flatness and integrity of the overall coating microstructure.

Introduction

Microstructural evaluation is a common approach for determining the quality of a thermally sprayed coating. Accuracy of the evaluation is dependent on the metallographic preparation used to reveal the microstructure. The need for careful consideration of sectioning and mounting techniques is essential prior to metallographic preparation. [1] Selection criteria has been established through testing by users of thermally sprayed coatings as well as the TSS Recommended Practices for Metallography committee. Improper mounting of some thermally sprayed coatings will directly affect the characteristics of the coating causing improper evaluation.

Ten coatings representing a range of coating properties, qualities and thicknesses were selected for this study of the performance of resin/diamond discs. All coatings were simultaneously prepared on EcoMet® 3000/ AutoMet® 2000 equipment. A preparation sequence was established using Apex® DGD Discs and the process was repeated numerous times to establish the consistency of the surfaces. EcoMet 3000/AutoMet 2000 and BuehlerVanguard® 2000 equipment produce the best, consistent results when metallographically preparing thermally sprayed coatings. [2]

The study revealed that whether the coatings are ceramic, soft or hard metallic or composite in nature, the resin/diamond surfaces produce good consistent results without damaging the coating. If good sectioning and mounting techniques are followed, the metallographic process will enable the observer to view a coating microstructure that is accurate in appearance. The surfaces used for the grinding and lapping of the coatings are shown in the SEM and light microscopy photographs in Figure 1 & 2.

Coating Materials

Ten diverse thermally sprayed coatings were provided by thermal spray equipment manufacturers. The coatings provided were Electric Arc Spray NiCrAl and 420 Stainless Steel, HVOF WC/CO,8% Yttria Stabilized Zirconia, Chrome Oxide, Plasma Sprayed NiAl, Copper, Two Wire Arc Stainless Steel and Aluminum Bronze, and Chrome Carbide. Spray parameters and coating thickness and substrate material varied with each coating type.

Metallographic Preparation

The metallographic preparation was performed on the 8 inch, EcoMet 3000/AutoMet 2000 Grinder-Polisher which has a power head that provided consistent applied loads while rotating the specimens with or against the rotation of the base platen during each step. This allowed for controlled, simultaneous preparation of the specimens. [3]

All the preparation sequences were started with a 45μm Apex disc to assure adequate material removal (1-2 mm). Two additional
Figure 3. (top) 45 micron DGD. Figure 4. (middle) 9 micron DGD. Figure 5. (bottom) 3 micron Napless Cloth.

Figure 6. (top) 8% YSZ. Figure 7. (middle) EAS NiCrAl. Figure 8. (bottom) 2 Wire Arc Al-Bronze.

Figure 9. (top) CrO. Figure 10. (bottom) EAS 420 Stainless Steel.

Figure 11. (top) Plasma NiAl. Figure 12. (bottom) Chrome Carbide.
grinding steps were conducted using a 9μm and 6μm Apex disc respectively which removed the previous deformation from the initial planar step. The final two steps involved the use of 3μm MetaDi® Supreme Diamond Suspension on a TexMet® 1000 Polishing Pad and MasterMet® (0.03μm) Colloidal Silica Suspension on a ChemoMet® Cloth. Figure 3, 4 & 5 show the surface characteristics after the 45μm, 9μm and 3μm resin/diamond disc procedures. Images were captured after the final polishing step revealing the results of this process and are shown in Figures 6-15.

Conclusions
Apex DGD Discs will consistently produce flat surfaces on a variety of thermally sprayed coatings and can be used for an extended period of time before losing their effectiveness. Initial observations reveal that these surfaces can be used to grind hundreds of specimens which provides a big cost savings for laboratories who consistently use silicon carbide abrasive papers. Because the diamond is imbedded in a resin binder, the damage created during the grinding operation is much less that a metal bonded diamond disc.

Metal bonded diamond discs create deeper surface damage and provide greater material removal, but tend to create more damage on friable coatings. It can be concluded from this study that Apex DGD Discs can provide a cost effective method for metallographically preparing the thermally sprayed coating shown in this report and others with similar characteristics without producing unacceptable damage to the coatings while reducing the cost of preparation.

References

Results and Discussion
The images captured for documentation revealed flat, scratch-free surfaces, well defined coating/substrate interfaces and minimal coating defects. When the preparation procedure was repeated five times using the same surfaces and parameters, the results were similar.

Figure 6. (top) 8% YSZ. Figure 7. (middle) EAS NiCrAl. Figure 8. (bottom) 2 Wire Arc Al-Bronze.