

Standardization and Audit-Readiness in the Metallography Lab

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When evaluating the performance of a metallographic laboratory, there are a number of factors which must be considered. Excluding financial metrics, performance is typically measured by the output of that lab. Within the thermal spray industry, the output of a lab consists of mounted and polished specimens and/or reports which reflect the integrity of coatings being produced on the shop floor. However, by looking deeper, other metrics for evaluation become evident. How has the lab performed in audits? What types of controls/standards are used within the lab? Are the laboratory personnel properly trained? It is these criteria which we will focus on for this article.

The majority of companies (~60%) applying thermal spray coatings support the gas turbine industry¹. As a result, a large percentage of these companies are subject to certification requirements ranging from OEM (GE, Pratt & Whitney, Rolls Royce, etc.) to possibly Nadcap or A2LA. The intent of these certifications is to ensure that each laboratory is operating in a controlled manner, with thorough quality systems and documented procedures. Findings in the associated audits often reveal deficiencies related to documentation, calibration, or training. While minimizing the number of findings in an audit is very important, there are other factors which must be considered which may or may not be revealed during an audit.

One glaring weakness associated with the certification of metallography labs is the standardization of metallographic consumables. Suppliers of metallographic consumables are essentially free to determine the amount and/or particle size distribution of diamond they provide in their diamond suspensions. They are also free to sell a range of products described as “Silicon Carbide (SiC) Grinding Paper”. As an example, Figure 1 shows scanning electron microscope (SEM) images of the surfaces of two sheets of 180-grit SiC paper. While both papers are marketed identically (180-grit, C-weight paper, etc.), a cursory examination reveals differences between the papers in terms of abrasive particle density. By using a higher magnification to continue this comparison (Figure 2), differences in the orientation of the abrasive particles become apparent. In this case, one of the papers is manufactured using an electrostatic process which causes the abrasive particles to stand up when subjected to an electric field. The other paper does not use this manufacturing step. Studies have found that the paper made with the extra step will provide significantly higher material removal rates². What does this mean for your lab? Assuming you have well documented procedures with specific preparation recipes for specific coatings, blindly changing suppliers for the consumables used in your lab may result in variations in your final product. If your recipe calls for 3 sheets of 180-grit SiC paper as a first step to remove sectioning damage, and you unknowingly switch from electrostatic to standard SiC papers, you will actually remove much less material than expected. As a result, your samples may now exhibit cracks or induced porosity, even though you worked to a previously validated preparation recipe. As a result, inaccurate feedback may be provided to the shop floor, leading to process changes.

Another topic with regards to standards is the presence of metallographic standards in the laboratory. Most Nadcap accredited coatings labs already have these standards in place, albeit under a different name. As part of Nadcap requirements, round robin testing is required for the various coating families being sprayed (or evaluated) at a given facility. The round robin test involves the various lab personnel preparing and evaluating a particular coating sample or round robin sample. The results for each person should be within statistically allowable limits. Round

robin samples also make great standards. If, for example, the lab is in possession of a WCCo sample of known phase and porosity, that sample can be metallographically prepared with a rack of production samples. As long as the round robin sample goes through the preparation and exhibits the expected phase and porosity, it can be assumed that the production samples are also showing their true structure. In contrast, if the standard exhibits excessive porosity or smearing, the production samples are likely not showing their true structure.

Another way to evaluate a metallography laboratory is through both the internal and external training efforts. In a recent article written by Jack and Suzy Welch in *Business Week* (September 11, 2006, page 124), the authors talk about how preferred employers demonstrate a genuine commitment to continuous learning. Investment is made in their employees through classes, training programs, and other avenues. Unfortunately, many companies in the thermal spray industry see training requirements, such as those mandated by several OEMs, as a burden rather than an opportunity. Conversely, many of the highly successful organizations in the thermal spray industry exceed the mandated requirements and encourage personal development for their employees.

A way to evaluate the quality of a lab in the thermal spray industry, other than financially, includes new metrics. These performance metrics of a metallographic laboratory include successful completion of compliance audits, having the types of controls and standards that are crucial to the lab, and investing and supporting properly trained personnel.

1 iTSSe, May 2006, Volume 1, Issue 1, page 15.

2 JTST, March 2006, Volume 15, Number 1, page 31.

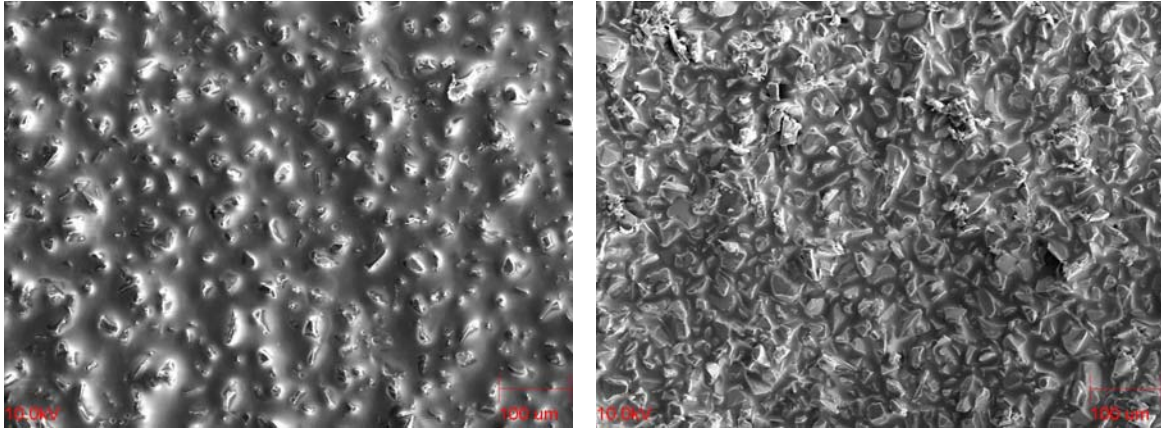


Figure 1: SEM photomicrographs of two sheets of 180-grit SiC abrasive paper, produced by electrostatic (left) and standard (right) methods. In these images, differences in abrasive density are apparent.

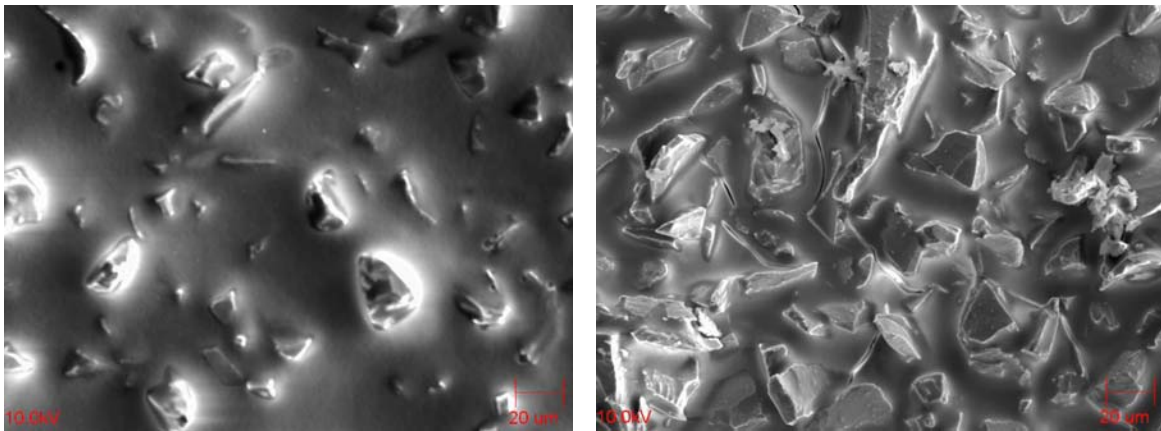


Figure 2: Same SiC samples as shown in Figure 1. At higher magnification, differences in abrasive particle orientation due to the manufacturing process can be more readily seen.