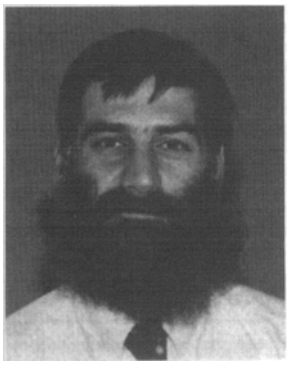
Editorial

The Impact of Standards and Specifications



The common English language definition of "standard" (from Webster's New Unabridged Dictionary, 2nd Edition) is "something established for use as a rule or basis of comparison in measuring or judging capacity, quantity, content, extent, value, quality, etc." A "specification" may be defined as, "a particular and detailed account or description of a thing." However, the technical meanings of standards and specifications are different and should not be confused with the above layperson understanding. For example, the American Society for Testing and Materials (ASTM) is a scientific and technical organization formed for the development of voluntary consensus standards. The term 'standard' serves ASTM as "an adjective in the title of documents, such as test methods or specifications, to connote specified consensus and approval." A specification is defined as "a precise statement of a set of requirements to be satisfied by a material, product, system, or service that indicates the procedures for determining whether each of the requirements is satisfied."

Standards and specifications abound in the thermal spray industry. The meeting or approval of a certain standard or specification can often be the difference between success and failure of a product, process, or material, and hence, company or individual. In short, standards and specifications can be thought of as our own regulatory watchdogs. The following are some examples to illustrate the above technical definitions:

An example of a standard is ASTM C633, which is entitled "Standard Method of Test for Adhesion or Cohesive Strength of Flame-Sprayed Coatings." This document presents a consensus from a panel of industrial and academic experts of practical details for performing a test to measure a property of coatings that is termed "adhesion or cohesive strength." The document further defines the technical meaning of these so-determined properties. The standard does not claim to relate these properties to operational stresses on coatings, nor are any numerical values for specific coating systems presented. The purpose of any standard is therefore to provide a testing framework, so that a property can be determined.

Specifications are a second-tier characteristic that stand on the shoulders of standards. Thus, a number of standard methods of material characterization are performed, and now the so-determined values may be used as a basis of judgment for the acceptance or rejection of the material. Vendors to the aircraft industry are well aware that Pratt & Whitney or GE specifications (among many others) determine whether their product will be accepted. The attainment of an industry standard is often written into the order for procurement, and noncompliance can lead, at best, to a nonacceptance of goods and, at the extreme, legal action. The cost and ramifications of the imposition of standards and specifications are not to be taken lightly. As an example, many powder vendors devote resources to ensure that the chemistry and particle size of thermal barrier coating powders are "within spec," so that an order can be procured.

Why go into these details? The reason is that not only do standards and specifications, as defined above, regulate the thermal spray industry, but they also, virtually by definition or normalization of all materials, constrain it. This statement is not to be interpreted as a call to anarchy, but a call to promote a little rationalization. Thus, it might be argued that not only are some of the standards, and therefore specifications determined from these standards, irrelevant for a particular coating application, but that the industry may be missing a commercial or technological opportunity by blindly following such procedures and recommendations. Of course, this confronting statement may not be true for homogeneous and isotropic materials (e.g., mild steel, ceramicware) that have an extended history where practical usage and the test of time have confirmed that the standards are acceptable. (I could also be tempted to bring up the example of the Liberty Class of ships that failed despite standards and specifications being in place—it was that inappropriate standards and specifications were used; and this is, as you will see, the point of this editorial.) The main point is that, at least in this author's experience, materials properties determined by many tests lead to useful performance correlations. However, such extrinsic correlations need not have causal relations with respect to intrinsic materials properties. Therefore, there is the danger that the full operational capabilities of coating/substrate systems are not being perfected.

It is easy to criticize existing documents, but the statement-of-fact for thermal spray coating technology is that the existing standards and specifications are followed and are likely to be followed for the next decade because (1) there are no other industry-accepted practices, and (2) the momentum and direction of industry is resistant to change. The key word is "industry," which is the prime driver for standards and specifications. The researchers in national laboratories and universities, who

have tackled such problems from a fundamental viewpoint, have learned that existing practices are quite rigid. Therefore, they have oriented their activities to fall into line with these practices, and obviously, this *modus operandi* has the pitfall that new knowledge and understanding of thermal spray coating systems is stymied.

The above controversy was brought home to the author during a recent discussion concerning properties of hydroxyapatite coatings that are intended for dental implants or for stems of orthopedic prostheses (e.g., hips). Thus, thermal spray coatings could very well be a preferred technology for the biomedical industry. Approval of these devices by the FDA will eventually hinge on meeting certain specifications determined by standard methods. Points of primary concern for this biomedical application include the measurement of strength, abrasion resistance, phase structure, and roughness. The aspects of roughness and abrasion resistance are quite important because micromotion in the application (dental implant or hip) may cause particulate removal that can bring about adverse tissue responses that lead to pain and possibly implant removal.

Questions of vital importance with respect to the impact of standards and specifications include: How do thermal sprayers measure such properties and characteristics of coatings? Are these properties reproducible from vendor to vendor? Is it reasonable to specify operational tolerances of thermal spray coatings in terms of, for example, strength and roughness? When you think about your responses to these questions, also remember that you may be the recipient of such a coating in the future!

This editorial is not intended to provide answers, but to identify the nature of an important challenge that thermal sprayers must meet. At present, standards and specifications are designed to assess coatings that exist and need not apply to the coatings of the future. Industrialists and researchers must address future needs for testing and evaluation of coatings if we are to overcome barriers of understanding that impede us from making the next logical step that advances thermal spray technology. Thus, testing and characterization of coatings, as defined by standards and specifications, can be considered the Achilles heel of the industry that prevents our progress.

The solution to these technical issues may not be simple, but the commercial and marketing implications are enormous. I am inviting your responses to my point of view and would like to know your position. Write me with your comments. I'll publish your letters as a forum to debate this key issue.

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