Designation: E423 – 71 (Reapproved 2014)

Standard Test Method for Normal Spectral Emittance at Elevated Temperatures of Nonconducting Specimens[1]

This standard is issued under the fixed designation E423; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

The general physical properties of ceramic materials combine to make thermal gradients a serious problem in the evaluation and use of thermal emittance data for such materials. Ceramic materials in general tend to be somewhat translucent, and hence emit and absorb thermal radiant energy within a surface layer of appreciable thickness. Ceramic materials in general also tend to have low thermal conductivity and high total emittance as compared to metals. These properties combine to produce thermal gradients within a heated specimen unless careful precautions are taken to minimize such gradients by minimizing heat flow in the specimen. The gradients tend to be normal to a surface that is emitting or absorbing radiant energy. As a further complication, the gradients tend to be nonlinear near such a surface.

When a specimen is emitting from a surface layer of appreciable thickness with a thermal gradient normal to the surface, it has no unique temperature, and it is difficult to define an effective temperature for the emitting layer. Emittance is defined as the ratio of the flux emitted by a specimen to that emitted by a blackbody radiator at the same temperature and under the same conditions. It is thus necessary to define an effective temperature for the nonisothermal specimen before its emittance can be evaluated. If the effective temperature is defined as that of the surface, a specimen with a positive thermal gradient (surface cooler than interior) will emit at a greater rate than an isothermal specimen at the same temperature, and in some cases may have an emittance greater than 1.0. If the thermal gradient is negative (surface hotter than interior) it will emit at a lesser rate. If the "effective temperature" is defined as that of an isothermal specimen that emits at the same rate as the nonisothermal specimen, we find that the effective temperature is difficult to evaluate, even if the extinction coefficient and thermal gradient are accurately known, which is seldom the case. If spectral emittance is desired, the extinction coefficient, and hence the thickness of the emitting layer, changes with wavelength, and we have the awkward situation of a specimen whose effective temperature is a function of wavelength.

There is no completely satisfactory solution to the problem posed by thermal gradients in ceramic specimens. The most satisfactory solution is to measure the emittance of essentially isothermal specimens, and then consider the effect of thermal gradients on the emitted radiant flux when attempting to use such thermal emittance data in any real situation where thermal gradients normal to the emitting surface are present.

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