

METHOD AND APPARATUS FOR ARTIFICIAL WEATHERING

This application claims the benefit of Provisional application No. 60/016,731, filed May 2, 1996.

TECHNICAL FIELD OF THE INVENTION

The present invention is directed toward a method and apparatus for applying radiation to a specimen. In one embodiment, the invention is directed toward a method and apparatus for artificially weathering a specimen by irradiating the specimen with ultraviolet light.

BACKGROUND OF THE INVENTION

Materials such as textiles, rubber, leather, plastics, construction materials, and so forth are affected by the influence of sunlight and other climatic factors, such as moisture, temperature, and humidity. The effects of sunlight, particularly the ultraviolet component of sunlight, may cause changes in the molecular structure of such materials, which changes may be observed macroscopically as changes in the mechanical, electrical, optical, or other properties of the materials. In general, the change in properties is not favorable, and sunlight is thus said to cause such materials to degrade.

The degrading effects of ultraviolet light can be difficult to quantify, especially inasmuch as a number of other environmental and material factors will affect the rate at which such materials degrade. For example, various materials exposed to the same environmental conditions will all degrade at different rates. Moreover, the rate at which any one material will degrade varies widely depending on the environment in which the material is placed. In particular, factors such as humidity, moisture, temperature, acid deposition species and exposure to corrosive chemicals, and mechanical loading can cause dramatic variations in the service life of any such material. The particular combination of factors that will affect a specimen of material and the effect of any one of these factors on the specimen will differ with the application to which the specimen is put, the environment into which the specimen is placed, and the time of exposure to the environment.

Prior to the commercial introduction of an outdoor material, the weathering properties of the material should be known so that a useful service life may be estimated. In practice, the service life may be empirically estimated by placing a specimen of the material in its intended environment and measuring the useful service life. Because an empirical determination may require several months or years, however, the prior art has provided exposure chambers wherein the effects of sunlight and other environmental conditions may be simulated and accelerated. In a typical prior art exposure chamber, a specimen is placed in a light communicating relationship with a source of ultraviolet light, and other environmental factors, such as moisture and temperature, are monitored and/or controlled. The amount of ultraviolet light impinging on the specimen also may be controlled, and this amount typically is selected to simulate accelerated exposure to sunlight.

The usefulness of such an artificial weathering apparatus depends on a number of factors, one of the most important of which is the ability to control the spectral irradiance of the radiation impinging upon the test specimen. Although such control is desirable, it is particularly difficult to attain. One difficulty is that the light output of ultraviolet light sources such as xenon lamps is highly nonuniform. At any given

moment, the radiance from one portion of the light source may vary from the radiance from another portion of the light source, particularly when the light source is an elongate bulb. Thus, the irradiance of a radiation beam impinging on a test specimen may vary across the surface area of the test specimen. Moreover, the overall radiance, or intensity of light flux, produced by such light sources may decrease as the light source ages, thus making it difficult to provide a prolonged uniform testing environment for a test specimen.

Another difficulty in achieving uniformity of irradiation arises when it is desired to perform an experiment on plural test specimens. The light radiance from plural sources likely will vary from one light source to another. Thus, to ensure accuracy of experimentation, it is often desired to use the same light source to irradiate all of the samples. This can be difficult when the number of samples is great, and may necessitate seriatim testing of the specimens, thus lengthening the time required for the test. Moreover, because the radiance from even a single light source will vary over time, consistent sample irradiance can be difficult even when the tests are conducted using a single source of ultraviolet radiation.

The prior art has provided a number of attempts at solving the problem of nonuniformity in irradiance of test specimens. For example, U.S. Pat. No. 5,206,518 is said to disclose a weathering apparatus, including a ballast arrangement connected to the light source for controlling the amount of power the light source receives from a power source. A controller is said to be connected to the ballast arrangement, to produce a ballast control signal for controlling operation of the ballast arrangement according to a desired set-point value. U.S. Pat. No. 5,220,840 is said to disclose a method of calibrating the light output of a multi-lamp testing chamber, the method including steps of continuous adjustment of the power to each lamp. These proposed solutions are somewhat unsatisfactory, inasmuch as each is complex and cumbersome. Moreover, although in each case uniformity of irradiance is said to be achieved over one dimension, these references do not specifically address the problem of irradiance uniformity over a two-dimensional area of an irradiated specimen.

Another difficulty encountered in prior art artificial weathering apparatuses is that of quantitatively evaluating the effects of other environmental variables on the degradation of the specimen. If the uniformity of irradiance of impinging radiation on the specimen is not known, it will be difficult or impossible to determine the significance of environmental factors other than ultraviolet light. The prior art is not believed to have addressed this problem. For example, U.S. Pat. Nos. 3,664,188 and 4,012,954 each purport to disclose a testing apparatus in which certain environmental conditions may be varied. Neither reference, however, addresses the problem of irradiance uniformity.

It is a general object of the present invention to provide a method and apparatus for irradiating a specimen. Another general object of the invention is to provide a method and apparatus for irradiating a specimen wherein other environmental factors may be variably controlled.

SUMMARY OF THE INVENTION

The inventors have discovered that the foregoing general objects may be satisfied by the use of an integrating sphere to provide a uniform radiation source for uniform irradiation of test specimens. An integrating sphere may be defined as a hollow chamber, preferably spherical or generally spherical, that has an inner surface including a highly