destructive inspection techniques that can indicate cumulative effects on structural components after being exposed to environmental conditions such as repetitive loading, impacts, high temperatures and the like during operation. Such indications may lead to the scheduling of further evaluation, maintenance and/or replacement of the structural components at appropriate times.

Summary of the Disclosure

In one aspect of the present disclosure, a method for assessing strain in a structural component is disclosed. The method may include creating a geometric pattern of grooves on the structural component having a first set of grooves each having a first groove width and a second set of grooves each having a second groove width, and illuminating the geometric pattern of grooves with a first light at a band of first wavelength that corresponds to the first groove width to create diffraction when the first light hits the geometric pattern of grooves and a second light at a band of second wavelength that corresponds to the second groove width to create diffraction when the second light hits the geometric pattern of grooves, and corresponding changes in the a wavelength of light reflected from the geometric pattern of grooves indicating changes in the first groove width and in the second groove width due to strain caused when the structural component is exposed to environmental conditions. The method may further include detecting the wavelength of the light reflected from the geometric pattern of grooves as the first light and the second light illuminate the geometric pattern of grooves, and correlating the detected wavelength of the light reflected from the geometric pattern of grooves to the strain in the structural component.

In another aspect of the present invention, an inspection system for assessing strain in a structural component is disclosed. The inspection system may include a geometric pattern of grooves on the structural component having a first set of grooves each having a first groove width and a second set of grooves each having a second groove width, a first illumination source projecting a first light at a band of first wavelength that corresponds to the first groove width to create diffraction when the first light hits the geometric pattern of grooves and a second illumination source projecting a second light at a second band of wavelength that corresponds to the second groove width to create diffraction when the second light hits the geometric pattern of grooves, corresponding changes in wavelength of the light reflected from the geometric pattern of grooves indicating changes in the first groove width and in the second groove width due to strain caused when the structural component exposed to environmental conditions, and a detector detecting the wavelength of the light reflected from the geometric pattern of grooves as the first illumination source and the second illumination source illuminate the geometric pattern of grooves with the first light and the second light. The inspection system may further include a processor operatively

connected to the detector and configured to receive the detected wavelength of the light from the detector and to correlate the detected wavelength of the light from the geometric pattern of grooves to the strain in the structural component.

In a further aspect of the present disclosure, a method for assessing strain in a structural component is disclosed. The structural component may have a geometric pattern of grooves on the structural component, and the geometric pattern of grooves having a first set of grooves each having a first groove width. The method may include illuminating the geometric pattern of grooves with a first light at a first wavelength that corresponds to the first groove width to create diffraction when the first light hits the geometric pattern of grooves and corresponding changes in the wavelength of the light reflected from the geometric pattern of grooves indicating changes in the first groove width due to strain caused when the structural component is exposed to environmental conditions, detecting the wavelength of the light reflected from the geometric pattern of grooves as the first light illuminates the geometric pattern of grooves, and correlating the detected wavelength of the light reflected from the geometric pattern of grooves to the strain in the structural component. Additional aspects are defined by the claims of this patent.

Brief Description of the Drawings

Fig. 1 is an isometric view of a structural component of a mechanical system having a geometric pattern of grooves in accordance with the present disclosure;

Figs. 1A-1G are plan views of embodiments of geometric patterns of grooves in accordance with the present disclosure for the structural component of Fig. 1;

Fig. 2 is an isometric view of a portion of a mechanical system with a patch installed thereon having a geometric pattern of grooves in accordance with the present disclosure;

Fig. 3 is a cross-sectional view of the portion of the mechanical system and the patch taken through line 3—3 of Fig. 2;

Claims:

1. A method for assessing strain in a structural component, comprising:

creating a geometric pattern of grooves on the structural component having a first set of grooves each having a first groove width and a second set of grooves each having a second groove width;

illuminating the geometric pattern of grooves with a first light at a band of first wavelength that corresponds to the first groove width to create diffraction when the first light hits the geometric pattern of grooves and a second light at a band of second wavelength that corresponds to the second groove width to create diffraction when the second light hits the geometric pattern of grooves, and corresponding changes in a wavelength of light reflected from the geometric pattern of grooves indicating changes in the first groove width and in the second groove width due to strain caused when the structural component is exposed to environmental conditions;

detecting the wavelength of the light reflected from the geometric pattern of grooves as the first light and the second light illuminate the geometric pattern of grooves; and

correlating the detected wavelength of the light reflected from the geometric pattern of grooves to the strain in the structural component.

2. The method of claim 1, wherein the geometric pattern of grooves comprises a two-dimensional pattern having a first set of grooves spaced in a first direction and a second set of grooves spaced in a second direction that is not parallel to the first direction.

3. The method of claim 1, wherein grooves of the geometric pattern of grooves have a similar geometric shape and define increasing areas, with the grooves being arranged concentrically to form the geometric pattern of grooves.

4. The method of claim 1, wherein the grooves are formed on an appliqué that is applied to and adhered to the surface of the structural component.

5. The method of claim 1, wherein the band of first wavelength of the first light is outside a range for visible light.

6. The method of claim 1, wherein correlating the detected wavelength of the light comprises converting the detected wavelength of the light into strain values at corresponding locations of the structural component.

7. The method of claim 1, comprising:

illuminating the geometric pattern of grooves a first time before the structural component is exposed to an environmental condition;

detecting the wavelength of the light reflected from the geometric pattern of grooves as the first light illuminates the geometric pattern of grooves the first time;

illuminating the geometric pattern of grooves a second time after the structural component is exposed to the environmental condition;

detecting the wavelength of the light reflected from the geometric pattern of grooves as the first light illuminates the geometric pattern of grooves the second time; and

comparing the wavelength of the light detected as the first light illuminates the geometric pattern of grooves the second time to the wavelength of the light detected as the first light illuminates the geometric pattern of grooves the first time to determine changes in strain at corresponding locations of the structural component.

8. An inspection system for assessing strain in a structural component, comprising:

a geometric pattern of grooves on the structural component having a first set of grooves each having a first groove width and a second set of grooves each having a second groove width;

a first illumination source projecting a first light at a band of first wavelength that corresponds to the first groove width to create diffraction when the first light hits the geometric pattern of grooves and a second illumination source projecting a second light at a second band of wavelength that corresponds to the second groove width to create diffraction when the second light hits the geometric pattern of grooves, corresponding changes in wavelength of the light reflected from the geometric pattern of grooves indicating changes in the first groove width and in the second groove width due to strain caused when the structural component is exposed to environmental conditions;

a detector detecting the wavelength of the light reflected from the geometric pattern of grooves as the first illumination source and the second illumination source illuminates the geometric pattern of grooves with the first light and the second light; and

a processor operatively connected to the detector and configured to receive the detected wavelength of the light from the detector and to correlate the detected wavelength of the light from the geometric pattern of grooves to the strain in the structural component.

9. The inspection system of claim 8, wherein the geometric pattern of grooves comprises a two-dimensional pattern having a first set of grooves spaced in a first direction and a second set of grooves spaced in a second direction that is not parallel to the first direction.

10. The inspection system of claim 8, wherein grooves of the geometric pattern of grooves have a similar geometric shape and define increasing areas, with the grooves being arranged concentrically to form the geometric pattern of grooves.

11. The inspection system of claim 8, wherein the band of first wavelength of the first light is outside a range for visible light.

12. The inspection system of claim 8, comprising a layer of material covering the geometric pattern of grooves, wherein a material in the layer of material is transparent when illuminated by the first light having the first wavelength.

13. The inspection system of claim 8, comprising a portable inspection device containing the first illumination source and the detector, and transmitting the detected wavelength of the light to the processor via wireless communications.

14. The inspection system of claim 8, wherein the first illumination source is capable of projecting light at different wavelengths.