

The Use of the Acoustic Emission Technique for Materials Research and Structural Integrity Monitoring

Principle

Acoustic emissions are high frequent, transient sound waves emitted when rapid local stress redistributions occur in a material. The stress redistributions are normally caused by the generation of structural changes in a material under a general loading condition. Examples of structural changes are crack growth, phase transformations, corrosion, wear,... Loading can be mechanical, thermal or chemical.

Detection

The emitted stress waves can be detected by coupling piezo-electric sensors to the surface of the structure under study. By analysing the quantity and the properties of the acoustic emission signals, information can be obtained about the processes that are active in the material under loading. This technique possesses a number of advantages : it offers the possibility to perform a continuous investigation of the material, processes can be monitored at the time and place of occurrence, a large structure can be monitored by a limited number of sensors, the spatial location of the signal origin can be calculated by using the signal arrival times at a number of sensors,...

Application in Materials Research

The acoustic emission technique finds one of its largest application fields in materials research. Examples are the detection of the point of damage initiation and the rate of damage evolution under mechanical loading (tensile, bending, fatigue, creep), the discrimination between different damage phenomena occurring simultaneously in composite materials (matrix cracking, delamination, fibre fracture), the study of phase transformations, the detection of coating wear,... Generally, the acoustic emission technique can be used to obtain information about the microstructural changes that are occurring in any loaded material. It thus contributes to a larger and more in depth understanding of the behaviour of these materials.

Application in Structural Integrity Monitoring

The main area where the acoustic emission technique has found practical, industrial applications is in the field of structural integrity monitoring. By equipping a loaded, safety critical structure with a number of piezo-electric sensors, information can be gathered about the evolution of damage in the structure during its service life. Alternatively, structural integrity can be monitored on a periodic basis by applying proof loads and detecting AE signals. It's important to realise that the AE technique requires the monitored structure to be under load and that only active damage processes are detected. A good example of this type of application is the monitoring of pressure vessels, chemical reactors or storage tanks.

Conclusion

Because the physical process of acoustic emission occurs in a wide variety of materials and under a large range of loading conditions, the technique offers great potential for use as a continuous monitoring technique. Due to its inherent advantages as compared to other techniques, it should always be considered when continuous detection is required.

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