An Enhanced Method of Embedding Thin Film Sensors

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WARF: P07193US

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing an improved method for embedding microsensors directly into a wide variety of metal and ceramic materials.

Overview

Surface mounted and exposed sensors are used in objects commonly found in a modern society that range from simple temperature monitors to complex airbag ejection systems. But sensors located on the surface of a device can hinder the functionality of the material mass, such as dies and tool bits, or the components of machines, such as turbine blades, pressure vessels, or pipes. Moreover, due to the size and shape of the device, mounting sensors to the surface is not always feasible.

In many cases, it is more practical and advantageous to embed sensors into devices for prognostic and diagnostic purposes. Additionally, embedded sensors significantly improve the ability to monitor real time manufacturing processes in harsh environments, such as high temperature, severe stress/strain, rapid loading, and highly corrosive and oxidative conditions.

The methods currently used for embedding sensors in metals and/or ceramics result in substandard sensor and insulation film quality or only can be used for limited types of materials. A new approach for embedded sensors is needed that produces high quality sensors and is applicable to a wide array of materials with different shapes and/or sizes.

The Invention

A UW-Madison researcher has developed an improved method to embed microsensors into a wide array of metallic and ceramic materials of various dimensions through a unique combination of standard microfabrication and diffusion bonding techniques.

The thin film sensor is produced using photolithography, lift-off etching and other microfabrication techniques. Then the microsensor is positioned between a base part and a cover piece that can be joined together by diffusion bonding. This process takes place in a protective atmosphere or vacuum. The surface of the cover piece is polished before bonding to avoid damaging the thin films and to reduce local pressures during bonding. The bonding surfaces may contain an interlayer to improve bond quality and/or reduce required bonding temperature, particularly when bonding ceramic to ceramic and ceramic to metal.

After bonding, the finished structure acts as a single functional component with the ability for the bonded area to possess a mechanical strength equal or close to the base material. Subsequently, sensors consisting of a stack of thin films are fabricated on the bonded material, layer by layer, in a clean-room environment by standard thin film deposition and patterning techniques. This approach is capable of joining both small and large components composed of similar or dissimilar material combinations of various alloys and ceramics, thus expanding the applications for embedding sensors.

Applications

- Embedding sensors in parts/tools, such as cutting tools, turbine blades and friction stir welders that undergo high temperatures and/or high stress.

Key Benefits

- Provides an enhanced method for embedding sensors in a wide variety of combinations of metals and/or ceramics
- Provides an improved method for monitoring manufacturing processes, such as processes using high speed and dry machining cutting tools
- Improves lifetime of tools and components
- Sensors can be embedded in materials of any size or shape.

Additional Information

Related Technologies

- For more information about the inventor's previous technology for embedding sensors on a metal substrate, see WARF reference number P05140US.

Tech Fields

- Analytical Instrumentation, Methods & Materials : Sensors

For current licensing status, please contact Michael Carey at mcarey@warf.org or 608-960-9867