Research and Reports on Metals

Perspective A SCITECHNOL JOURNAL

Manufacturing and Evaluation of a Smart Composite with Nitinol Reinforced Metal Matrix

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Received date: 01-Feb-2023, Manuscript No. RRMT-23-93475;

Editor assigned date: 03-Feb-2023, PreQC No. RRMT-23-93475(PQ);

Reviewed date: 17-Feb-2023, QC No. RRMT-23-93475;

Revised date: 24-Feb-2023, Manuscript No. RRMT-23-93475(R);

Published date: 03-Mar-2023, DOI: 10.4172/Rrmt.1000161.

Description

Smart composites are materials that exhibit specific properties in response to external stimuli, such as changes in temperature, magnetic or electric fields, or stress. Nitinol is a alloy that can recover its original shape when heated above a certain temperature. When embedded in a metal matrix, Nitinol can be used to smart composites with unique properties. Smart composites are materials that are designed to have unique properties that can be controlled or changed in response to external stimuli such as temperature, pressure, or electrical fields. These composites are made by combining different materials, such as polymers, ceramics, and metals, into a single material with enhanced functionality. Smart composites have a wide range of potential applications, including in the aerospace, automotive, and medical industries. For example, in aerospace, smart composites could be used to self-healing structures that can detect and repair damage. In the automotive industry, smart composites could be used to lightweight, high-strength materials that can change shape or stiffness in response to different driving conditions. In the medical industry, smart composites could be used to materials that can respond to changes in body temperature or chemical signals.

Manufacturing process of a smart composite with Nitinol reinforced metal matrix

Material selection: The matrix metal and Nitinol alloy must be selected based on their desired mechanical properties and compatibility with each other.

Powder metallurgy: The matrix metal and Nitinol alloy are typically processed using powder metallurgy techniques. In this process, the metal and Nitinol powders are mixed together and compacted under high pressure to form a green compact.

Sintering: The green compact is then heated in a sintering furnace to a temperature just below the melting point of the matrix metal. During sintering, the matrix metal particles fuse together, forming a solid metal matrix that embeds the Nitinol particles.

Hot Isostatic Pressing (HIP): In some cases, the sintered composite may be subjected to a Hot Isostatic Pressing (HIP) treatment to further improve its mechanical properties. During HIP, the composite is heated and pressurized in a high-pressure vessel, which helps to eliminate any remaining porosity in the material and improve its strength and ductility.

Machining and finishing: The final step in the manufacturing process involves machining and finishing the composite to the desired dimensions and surface finish.

The evaluation of a smart composite with Nitinol reinforced metal matrix typically involves mechanical testing to determine its strength, ductility, and other properties. Testing may include tension, compression, and bending tests, as well as fatigue testing to evaluate the material's durability over time. In addition to mechanical testing, the smart composite may also be evaluated for its shape-memory properties. This can be done by subjecting the material to temperature changes and observing its ability to recover its original shape. Other tests may be performed to evaluate the material's response to other external stimuli, such as magnetic fields or stress.

Citation: *Haldar P (2023) Manufacturing and Evaluation of a Smart Composite with Nitinol Reinforced Metal Matrix. Met Mater Int 7:1.*