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Method for Bonding Metal Injection Molded Parts to Conventional Substrate Using Controlled Surface Microstructure (2010-074)

Novel method which enables the benefits of MIM processing (complex geometries, special material properties) in critical areas of larger parts, at lower overall costs.

Market Overview

Metal Injection Molding (MIM) creates high-volume and highly specific metal parts that are restricted in size due to gravity. The primary obstacle manufacturers face with sinter bonding a MIM part to a conventional (solid) substrate is the sinter shrinkage (up to 20%) of the MIM part. This means that, except for dimensional changes due to thermal expansion, the MIM part shrinks during sintering and the conventional substrate maintains its dimensions. This behavior would typically inhibit bonding and/or cause cracking and deformation of the MIM part. The novel Metal Injection Molded (MIM) manufacturing method allows for the formation of intricate device geometries and attachment of dissimilar materials. By applying a controlled, deformable microstructure to the MIM part, the MIM part is given the ability to shrink while bonding to the substrate. The microstructure allows for certain deformation to follow the shrinkage without causing cracks in the compact. Furthermore, the new method combines advantages of powder injection molded parts with parts that are better manufactured by other processes. The broader impact of this work lies in enabling benefits of MIM processing in critical areas of larger parts in a wide variety of applications.

Technical Summary

Utilizing this new method, it is possible to bond Metal Injection Molded (MIM) parts through sinter bonding to a conventional substrate. In MIM, fine metal powders are mixed with a binder and injected into molds, similar to plastic injection molding. After demolding, the binder is removed from the part, and the compact is sintered to almost full density. This method achieves bond strengths between 150 to 450 MPa, which is up to 80% of the strength in resistance welds. Additionally, functionally designed composite assemblies can now be created through this method (e.g., high-wear areas on large assembly, magnetic–nonmagnetic assemblies, conductive/insulated assemblies) and feasibly manufactured.

Application

Automotive parts, biomedical surgical tools, defense, consumer products, industrial parts

Development Stage

Available for licensing

Advantages

- Competitive bonding strength similar to resistance welding.
- Flexibility of materials.
- Feasible integration into current manufacturing practices.
- Implemented in critical areas of larger parts at a lower overall cost.
- Reduces susceptibility to cracking.
- Improved shear strength over comparable methods.

About the Inventors

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Laine Mears is an automotive manufacturing researcher within Clemson University's Department of Automotive Engineering. Mears' research focuses on manufacturing quality estimation, intelligent machining systems, manufacturing process design and control, and manufacturing equipment diagnostics at the Clemson University International Center for Automotive Research (CU-ICAR). He is also the founding director of the Clemson Vehicle Assembly Center, a new national model for industry-driven training, workforce development and advanced assembly research.

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Dr. Martens received his PhD in Automotive Engineering at the Clemson University International Center for Automotive Research in 2011. Since then, with expertise in mechanical design, process development, and project coordination, Dr. Martens has had a variety of industry experience in both the United States and Germany. He has successfully executed complex projects, from inception to release, collaborating with diverse teams and third-party stakeholders with passion for driving innovation, ensuring product performance, and fostering cross-functional collaboration.

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