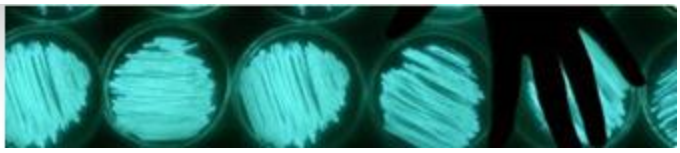
Technology Overview

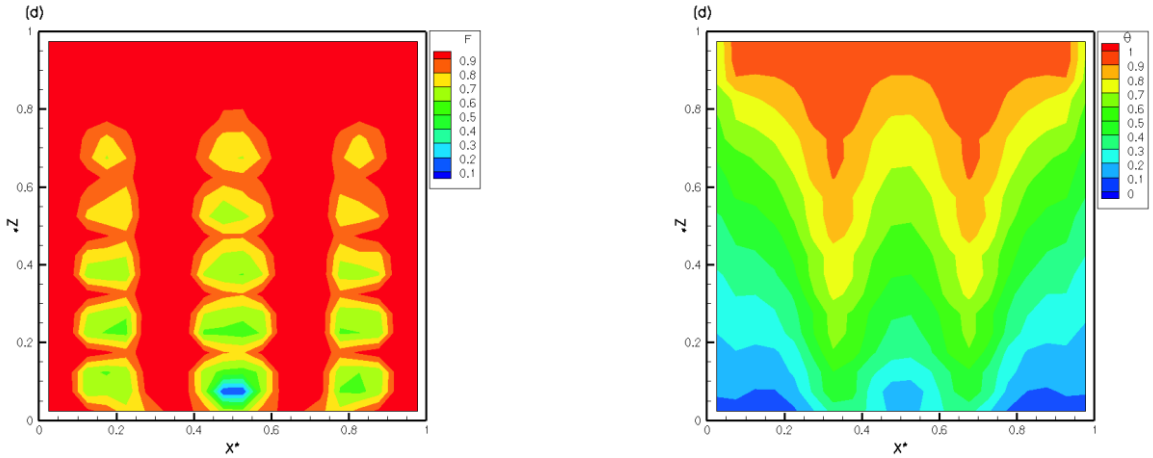


MIMPS: Metal IMpregnation Process Simulation Software

OTT ID# 1289

TECHNOLOGY

MIMPS© (Metal IMpregnation Process Simulation) is a comprehensive computational fluid dynamics program or code that simulates the incompressible flow, porous-medium infiltration, heat transfer, and solidification problems encountered during the Pressure Infiltration Process (PIP) for making the Metal Matrix Composites (MMCs). The finite difference method is implemented in the code to simulate flow and heat transfer behind a moving melt front in a fixed domain. The code can model the metal infiltration process in random-fiber (single-scale) preforms as well as in woven or stitched (dual-scale) preforms during the making of MMCs. A pseudo-dual-scale approach, which entails using two vastly different permeability values in the inter-tow and intra-tow regions of a preform while using the conventional single-scale flow model, is employed for modeling the non-isothermal unsaturated flow through a dual-scale porous medium. The geometry may be 2D or 3D, and the shape and geometry of tows may be changed to give maximum flexibility to the user. The approach of modeling the melt-flow through porous preforms using Darcy's law during the metal infiltration process achieves reasonable agreement with the experimental results for low Reynolds-number injections. After the PIP mold is full, MIMPS© can also model the subsequent metal solidification process. MIMPS© can serve as a powerful tool to optimize process conditions as well as the preform geometry in PIP while manufacturing MMCs.



(Left) A plot by MIMPS showing the formation of gas pockets inside fiber tows during PIP; (Right) A MIMPS plot illustrating a complex pattern of temperature distribution inside a PIP mold during processing.

FEATURES/BENEFITS

- CFD program that simulates metal infiltration of metal matrix composites
- Flexibility to run two-dimensional and three-dimensional simulations
- Capability to simulate subsequent metal solidification after metal infiltration simulation
- Reduce mold design expenditures and development time
- Models flow through inter-tow regions as wells as intra-tow regions

INTELLECTUAL PROPERTY

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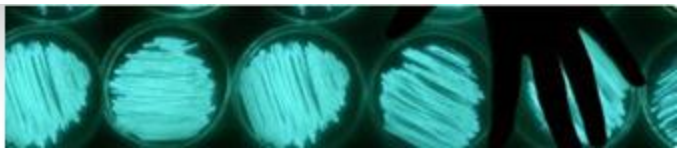

MARKETS

The metal matrix composites (MMC) market was recently estimated to exceed $282 million by 2015 where casting simulation software comprises a smaller segment of this market. MIMPS software is a specialized simulation program that would excel as an engineering design tool for the design of MMCs where complex features and prediction of flow make products especially challenging to manufacture. This software may be used in the development of any MMC with potential use in fields like metal matrix composite armor, aerospace, and civil engineering.

INVENTOR(S)

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Dr. Bo Wang is currently a research associate in the Department of Mateirals Science and Engineering at UW-Madison. Dr. Wang was a post-doc in the Department of Mechanical Engineering at UW-Milwaukee during 2010-2011. He works as a professor in the School of Materials and Metallurgy, Inner Mongolia University of Science and Technology in China. Dr. Wang research interests lie in the areas of flow, heat transport, and solidification phenomena in industry processes including the casting process, the pressure infiltration process for producing metal matrix composites, and diffusion in solids.

Dr. Krishna Pillai is an associate professor in the Department of Mechanical Engineering at UW-Milwaukee. Dr. Pillai's research interest lies in modeling flow and transport in porous media including modeling liquid infiltration through fibers during processing polymer composites, wicking of liquids, evaporation of multicomponent liquids, and metal infiltration through fibers during processing metal matrix composites. Dr. Pillai also has research interests in computational mechanics, computational heat transfer, and rheology of polymers.

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