**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI**
**SHORT ABSTRACT OF THESIS**

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| Programme of Study | : | Ph.D. |

Thesis Title: Dissimilar Friction Stir Welding of Low & High Melting Point Alloys and Its Numerical Thermal & Fluid Flow Analysis

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## SHORT ABSTRACT

A comprehensive understanding of metallography, heat generation, plastic deformation, and material flow/intermixing associated with the tool–workpiece intersection is required to substantially eradicate defects from the dissimilar friction stir welded joints. In this dissertation, an attempt was made to address the optimal dissimilar friction stir welding (FSW) process window through the experimental analysis, supported by the numerical modelling. The dissimilar material combination, i.e., shipbuilding grade DH36 steel & AISI 1008 steel, DH36 steel & 6061-T6 aluminum alloy (AA6061), and 304 stainless steel (304 SS) & AA6061 are chosen for the study. In the experimental work, the weld joints were characterized based on the mechanical performance, macro/microstructural studies, and quantification of intermetallic compounds (IMCs) & steel fragments. It is understood that the grain refinement and IMCs could improve the hardness. However, the thicker IMC layer and larger area fraction of steel fragments and IMCs reduced the joint strength and ductility of the joints. Numerically, the 3D transient thermal phenomenological models were established to compare the thermal history between FSW and plasma-assisted FSW of dissimilar steels. On the other hand, the steady-state multiphase thermal-fluid flow analysis based on computational fluid dynamics by incorporating a modified analytical model was performed for the steel & AA6061 combination. The volume of fluid method was implemented for the DH36 steel & AA6061 combination. A multi-species transport model (STM) coupled with a mixture model was established to simulate the dissimilar 304 SS & AA6061 joints for the first time. The simulation results revealed that the variation in welding parameters significantly affected the temperature and material flow properties (i.e., flow velocity, dynamic viscosity, and strain rate) and material intermixing around the high-speed rotating tool. The developed STM can capture the transversal/horizontal material flow features and embedded steel fragments/strips in the joints.