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Thermal Properties of Al_2O_3-AlSi12 Layered Composite: Experiments and Modelling

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Materials with high resistance to wear and capable of fast heat dissipation are required for modern brake disks in the automotive industry. For such application, one of the best-suited materials can be functionally graded aluminium-matrix composites with ceramic reinforcements due to their excellent bonding strength, reduction of thermal residual stress generated during manufacturing, resistance to wear, corrosion and thermal shocks [1]. Moreover, such materials are inhomogeneous in nature and their macroscopic thermal or mechanical properties vary over the volume from one end to another. Therefore, stepwise graded aluminium alloy (AlSi12) composites reinforced with aluminium oxide (Al_2O_3) particles are selected owing to their good combination of thermal and mechanical properties [2].

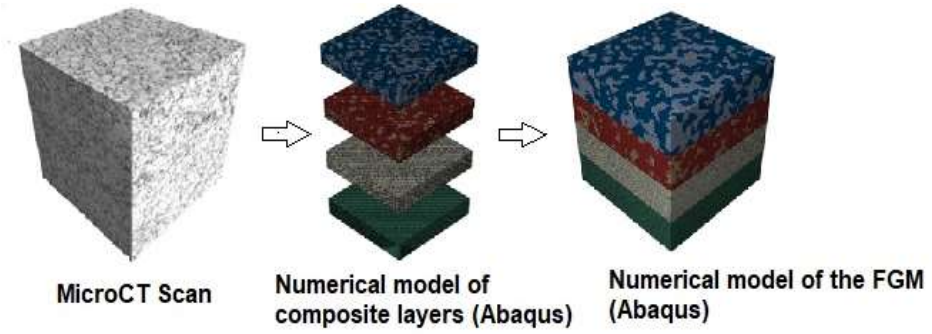

Figure 1. Micro-CT-based FEM modelling methodology

In this study, Powder Metallurgy techniques - Hot Pressing (HP) and Spark Plasma Sintering (SPS) are employed to fabricate Al_2O_3-AlSi12 graded composites. The effective thermal conductivity of the samples is evaluated using the Flash method, and the coefficient of thermal expansion is measured by dilatometry. For the numerical model, a 3D mesh is prepared from micro-CT scans of real material microstructure based on the methodology developed in [3]. The micro-CT-based FEM model for a non-graded composite is then extended to the FGM material (Fig. 1) allowing to consider the porosity of the layers (1%-3% depending on the layer). The effects of porosity and the ceramic reinforcement content on the thermal properties of the FGM are studied in detail given an envisaged application of this lightweight composite material in the automotive brake disk application. The predictions of the micro-CT-based FEM model of the overall thermal conductivity of the FGM agree very well with the experimental data.

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Lecture	Thermal Properties of Al2O3-AlSi12 Layered Composite: Experiments and Modelling Sequeira, A.A. (Speaker)[1]; Bochenek, K.[1]; Hutsch, T.[2]; Weglewski, W.[1]; Basista, M.[1] [1]Institute of Fundamental Technological Research POLISH ACADEMY OF SCIENCES, Warsaw (Poland); [2]Institute for Manufacturing Technology and Advanced Materials IFAM, Dresden

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