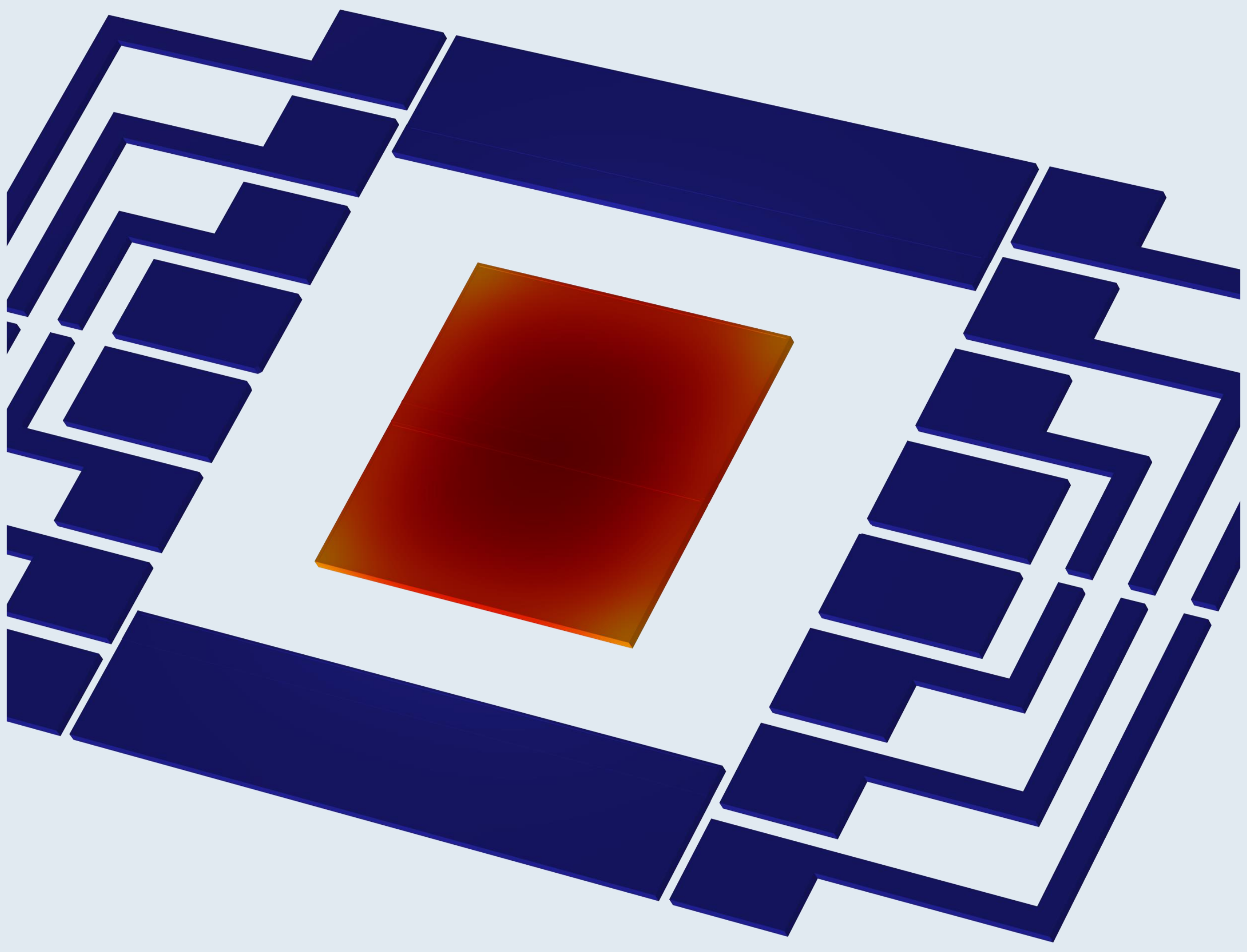

App for the thermal simulation of power electronics test devices

A user-friendly application enables thermal simulations of power electronics test devices. Users can upload layouts of their devices to build a model, simulate and post-process in the app.

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Abstract

In power electronics applications, microelectronic chips face swift temperature changes during operation, characterized by heat pulses of sub-millisecond duration with temperatures rising by hundreds of Kelvin. Over time, these conditions may lead to degradation in the metallization layers, posing a significant issue for reliability.

Silicon-based test chips with a 20-µm-thick copper metallization and integrated active heating have been developed to study power pulses with heating rates on the scale of 1 K/µs[1,2]. These conditions closely mirror those found in real-world applications and allow for highly controlled fatigue testing. The app streamlines the process of conducting thermal simulations of such tests without requiring in-depth knowledge of the COMSOL Multiphysics GUI.

Fig. 1 Light microscopy image of a test device showing copper pads for electrical functionality and central copper square subjected to thermomechanical loading.

Methodology

A 3D model of a test device for a given technology is generated from its GDS layout using the ECAD Import and Design modules. The Heat Transfer module's Thin Layer feature is employed to model functional layers that don't require detailed resolution, thus optimizing for minimal computational effort.

The design of this app incorporates the Application Builder form template to leverage predefined visualizations and input fields for parameters. It allows users to upload GDS layout files and experimental data. On completion of the transient thermal simulation, the app offers a visual representation of the temperature field, enabling users to interactively create local temperature evaluations.

Results

A test device with three temperature sensors has been specifically designed for validating the thermal simulations.

The sensors near the center and edge of the heated metallization (central square in fig. 1) and away from it enables us to verify that the heating and heat flow inside the device are predicted correctly (fig. 2).

Detailed knowledge of the exact material layers and their thermal properties allowed for an excellent agreement between measurement and simulation.

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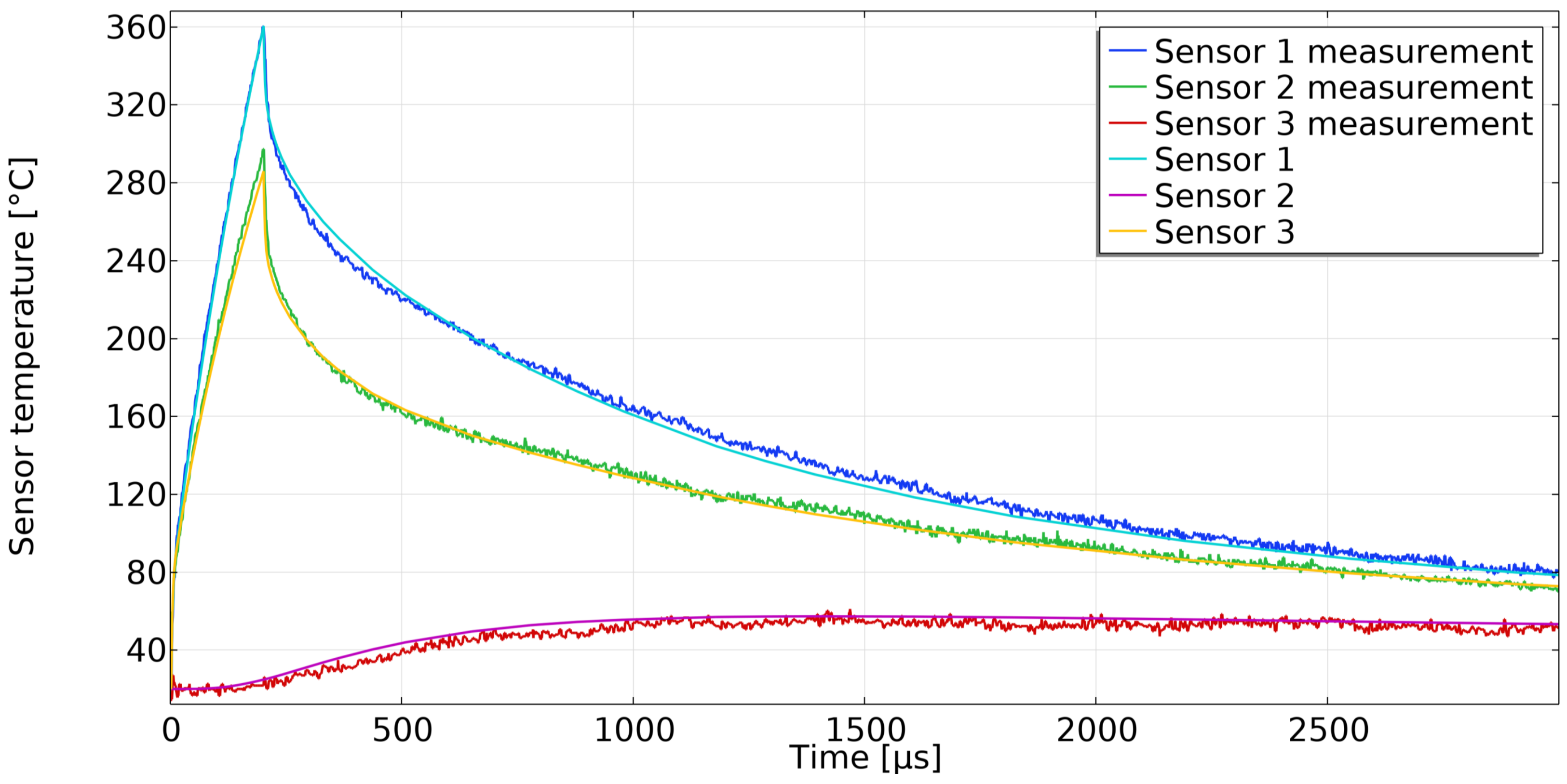

Fig. 2 Measured and simulated temperature in a purpose-built validation device.

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