NANODIMENSION
Electrifying Additive Manufacturing®

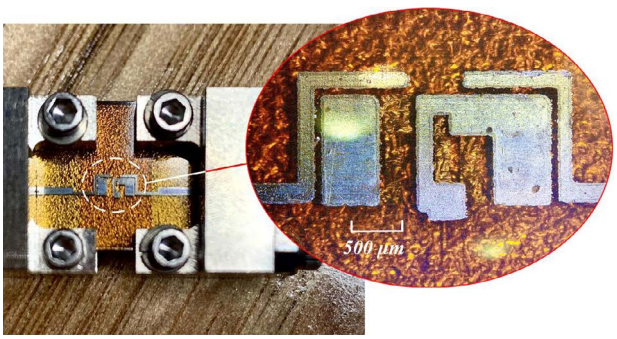
CASE STUDY: RESEARCH INSTITUTES

COMPACT AME MULTILAYER BANDPASS FILTER FOR CIRCUIT-IN-PACKAGE FOR X-BAND RADIO FREQUENCY FRONT-END

How the DragonFly® is helping designers make great leaps in precision electronic components

CLIENT

The ProtoSpace of University of Technology Sydney (UTS) is Australia's most advanced additive manufacturing facility located in the heart of Sydney. UTS ProtoSpace provides access to advanced 3D printing and scanning technologies along with specialized technical support, linked education, and engagement opportunities. Dr. Yang Yang is a group leader of Millimetre-Wave Integrated Circuits and Antennas at UTS Tech Lab, and currently a principal supervisor of five PhD students.



CHALLENGE

The upcoming wireless ecosystem will enable billions of high-speed wireless devices in a dynamic environment and, undoubtedly, highly-integrated AME device antennas, operating at millimeter-wave bands, packaged on mobile devices, will enable a new era of 5G IoT. However, the development of 5G AME devices is still in its infancy with several unique challenges still needing to be addressed.

Firstly, the high cost and long cycle of production for mm-wave antenna-in-package (AiP), which makes proof-of-concept customized prototyping difficult, especially for start-up/small businesses. Secondly, there is an urgent need for high-speed steerable multi-beam mobile antennas in a dynamic wireless environment. Thirdly, there is the question of how best to integrate and miniaturize packaged antenna arrays in small form factors without losing critical performance. Lastly, the gains from conventional device antennas have been stretched to their limit and are no longer suitable for future wireless communications – a new class of beam-forming AiP is urgently needed.

THE SOLUTION

Based on the proof-of-concept obtained from a pilot project between UTS and Nano Dimension, Dr. Yang and his team discovered a unique AME solution for 5G mm-wave antenna-in-package (AiP) designs by delivering single-substrate multiple conductive layers AiP, with customized package profiles, without risking confidentiality and intellectual property security.

Distinguished from well-developed mobile AiP technology, using PCBs, which are often found to be bulky and difficult to be fully integrated with multiple chips, the proposed AME AiP solution seamlessly bridges the gap between the AME AiP and chips. Most importantly, the prototyping cost is far cheaper than traditional methods, which requires a minimum panel order at an exaggerated price, making the realization of initial proof-of-concept more difficult.

THE RESULTS

This paper presented an additively manufactured bandpass filter (BPF) based on a second-order stub-loaded resonator consisting of multi-metal layer components. The proposed BPF is fabricated by a low-temperature (140°) additively manufactured electronics (AME) solution that can fabricate conductive and dielectric materials simultaneously with multi-metal-layer and flexible interlayer distance. By reducing the interlayer distance, constant inductance and capacitance can be realized in smaller sizes, which helps to achieve device minimization.

Taking advantage of this inkjet printing technology, a second-order multi-metal layer resonator is proposed. To understand the principle of the BPF, an equivalent circuit with odd- and even-mode analysis is demonstrated. For verification, the frequency response of the circuit's mathematical model is calculated to compare with the electromagnetic simulation results. Good agreement can be achieved among the calculated, simulated, and measured results.

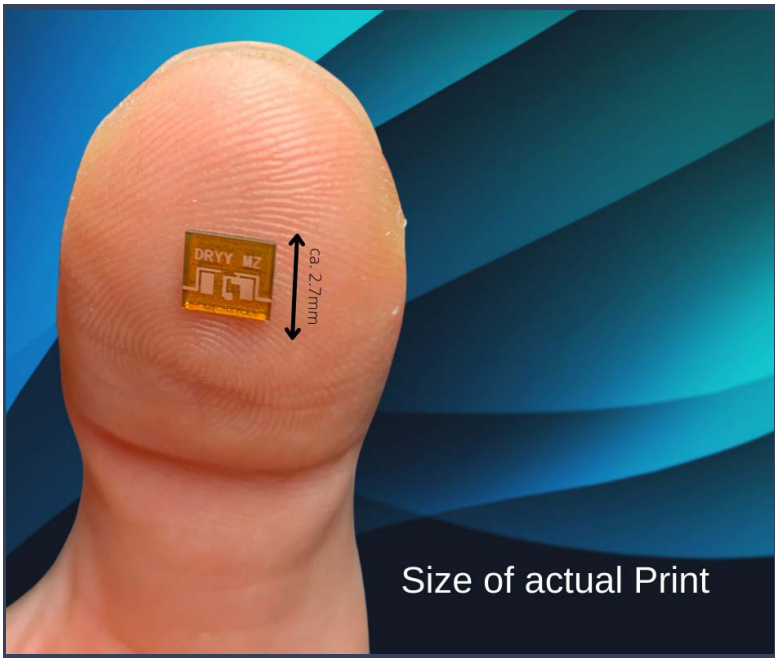
The proposed BPF is designed at 12.25GHz with a bandwidth of 40.8% and a compact size of 2.7 mm × 1.425 mm × 0.585 mm or 0.186λg × 0.098λg× 0.040λg, which is suitable for circuit-in-package applications in television programs, radar detection and satellite communications.

KEY ADVANTAGES

The DragonFly is the industry's only comprehensive additive manufacturing platform. It provides significant advantages in electronic circuits and antennas that are set to be widely used in 5G IoT electronics. It'shelping start-ups and small and medium businesses, protect IP, and prototype fast at a low cost.

In this work:

- the solution seamlessly bridges the gap between the AME AiP and chips
- single-substrate multiple conductive layers AiP was delivered
- constant inductance and capacitance can be realized in smaller sizes by reducing the interlayer distance



This case study is based on a published research paper.

Download the Paper Here