PURDUE UNIVERSITY | Elmore Family School of Electrical and Computer Engineering

Christopher Nordquist
Sandia National Laboratories

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ABSTRACT

Heterogeneous Integration for Next-Generation RF Microsystems.

Heterogeneous Integration (HI) reduces size weight and power (SWaP) and provides high-density electrically short interconnect by eliminating the overhead of traditional packaging, thus enabling electronic microsystems to perform functions beyond that achievable with any single technology. A practical HI strategy must allow for a broad range of technologies and materials: state-of-the art electronics such as advanced node CMOS integrated circuits, specialty electronics such as compound semiconductor RF or power electronics, optoelectronic components in either silicon or compound semiconductors, microelectromechanical components, RF passives and antennas, high-density connectors, and advanced early-stage R&D prototypes in emerging technologies. In all cases, supply chain and economic realities force tradeoffs between realizing the smallest integrated microsystem with the tightest integration dimensions versus lower cost manufacturable approaches with somewhat relaxed interconnect densities.

Given this diversity of materials and processes, our adaptable and scalable approach is to fabricate devices separately, through internal or external sources, followed by 2.5D integration of these devices onto high-density interposers. This approach allows access to a variety of technologies and components but is complicated by the dominance of the pure-play foundry model, prohibitive cost of full wafer runs, limited supplier options for given technologies, and small product quantities with limited learning cycles. To address some of these issues, we have been exploring single-die processing of underbump metals, interposers with solder and metal pillars for flip-chip integration, and other approaches targeting these technology sets.

This presentation will start with an overview of Sandia, followed by a summary of Sandia's Microsystems capability and early-stage research activities in next-generation microsystem device technologies. Finally, the presentation will focus on RF miniaturization technology developments and a vision for an adaptable and scalable 2.5D approach for heterogeneous integration within practical limits of technology access, development costs, and turn-time.

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BIO

Christopher D. Nordquist received B.S., M.S., and Ph. D. degrees in electrical engineering from Penn State in 1997, 1998, and 2002. At Penn State he was a research assistant and NDSEG Fellow, where he explored technology integration using self-assembly. In 2002, he joined Sandia National Laboratories, where he is currently Distinguished Staff in the RF Microsystems Department. He researches emerging micromachined and solid-state devices, and has explored a broad range of technologies including Si, GaAs, InP, GaN, MEMS, and advanced materials. Dr. Nordquist is a Senior Member of the IEEE and has co-authored over 90 publications and 12 patents.

Contact: Karen Jurss | Mobile: (765) 426-3213 | kjurss@purdue.edu