Three-dimensional Integrated Circuits: Design, EDA, and Architecture
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Three-dimensional Integrated Circuits: Design, EDA, and Architecture

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Abstract

The emerging three-dimensional (3D) integration technology is one of the promising solutions to overcome the barriers in interconnection scaling, thereby offering an opportunity to continue performance improvements using CMOS technology. As the fabrication of 3D integrated circuits has become viable, developing CAD tools and architectural techniques are imperative for the successful adoption of 3D integration technology. In this article, we first give a brief introduction on the 3D integration technology, and then review the EDA challenges and solutions that can enable the adoption of 3D ICs, and finally present design and architectural techniques on the application of 3D ICs, including a survey of various approaches to design future 3D ICs, leveraging the benefits of fast latency, higher bandwidth, and heterogeneous integration capability that are offered by 3D technology.
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Introduction

With continued technology scaling, interconnection has emerged as the dominant source of circuit delay and power consumption. The reduction of interconnect delays and power consumption are of paramount importance for deep-sub-micron designs. Three-dimensional integrated circuits (3D ICs) are attractive options for overcoming the barriers in interconnection scaling, thereby offering an opportunity to continue performance improvements using CMOS technology.

3D integration technologies offer many benefits for future microprocessor designs. Such benefits include: (1) The reduction in interconnection wire length, which results in improved performance and reduced power consumption; (2) Improved memory bandwidth, by stacking memory on microprocessor cores with TSV connections between the memory layer and the core layer; (3) The support for realization of heterogeneous integration, which could result in novel architecture designs. (4) Smaller form factor, which results in higher packing density and smaller footprint due to the addition of a third dimension to the conventional two-dimensional layout, and potentially results in a lower cost design.

This monograph first presents the background on 3D integration technologies, and shows the major benefits offered by 3D integration.
2 Introduction

As a key part, EDA design tools and methodologies for 3D ICs are reviewed. The designs of 3D FPGAs and micro-architectures are then discussed, which leverage the benefits of fast latency, higher bandwidth, and heterogeneous integration capability that are offered by 3D technologies. The cost of 3D integration is also analyzed in the last section.
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