Preface

This book presents a wide-band and technology independent SPICE-compatible *RLC* model for TSVs in 3D ICs. This proposed model accounts for a variety of effects, including skin effect, depletion capacitance, and nearby contact effects. The TSV is modeled like a MOS structure where it is assumed that a full depletion region exists around the TSV. A lumped parameter model is then proposed to model the TSV. The equivalent circuit model includes a single TSV model and coupling model between TSVs. The dimensional analysis method is applied to obtain closed form solutions for the resistance, capacitance, and inductance of the TSV lumped model. The accuracy of the expressions is then verified with the electromagnetic field solver under typical high-density TSV dimensions, and it shows a significant accuracy up to 100 GHz.

Although there are several works in the literature that provide an *RLC* model for a TSV and closed form expressions with different levels of accuracy, this book discusses models that exhibit several additional enhancements as compared to existing literature. The models in this book include: (1) MOS depletion R and C effect. (2) Body contact effect. (3) Model linearization, i.e., single nonlinear or frequency-dependent element can be approximated by multiple linear, and frequency-independent elements. (4) Simulation comparisons (e.g. with full-wave, quasi-static, and device simulation). This book can be very useful in the fast SPICE-compatible parasitic extraction of TSVs for 3D IC design.

Moreover, a proposed architecture based on TSV technology for a spiral inductor is demonstrated and characterized. Also, in this book, and for the first time, a novel inductive coupling interface that uses the magnetic near field induced by TSV-based spiral inductor is demonstrated. The feasibility of using TSV for wireless near field communication is shown. A TSV-based near-field inductive-coupling system offers a high quality factor and a good coupling coefficient. Therefore, the proposed communication system appears to be a promising technology for wireless communication. Moreover, another application for the TSV, which is bandpass filter, is discussed in this book.

This book presents the effects of substrate doping density on the electrical performance of TSV. Moreover, parasitic coupling capacitive between through-silicon vias and surrounding wires is analyzed and studied. Noise coupling between TSVs and CMOS is also investigated.

This book also presents several new directions for TSV fabrication and use in design. It presents performance comparison between Air-Gap Based Coaxial TSV and conventional circular TSV. Air-gap TSVs reduce the energy loss compared to the conventional circular TSV or conventional coaxial TSV. Moreover, SW-CNT bundles as a prospective filler material for TSV are investigated compared to conventional filler materials like Cu, W, and poly-silicon. CNT-filled TSVs have superior performance compared to Cu-filled TSVs, resulting in reduction in transmission loss at high frequency of operation. Moreover, TSV-based ADIABATIC logic based on the adiabatic switching principle is presented and analyzed.

Springer

http://www.springer.com/978-3-319-07610-2

Arbitrary Modeling of TSVs for 3D Integrated Circuits

Mohamed, K.S.; Ismail, Y.; El-Rouby, A.

2015, IX, 179 p. 159 illus., 99 illus. in color., Hardcover

ISBN: 978-3-319-07610-2