MINOS

PhD Thesis
Proposition

Subject:

Generation of noise and electromagnetic coupling in sequential 3D technologies: study, modeling and impact on circuit performance.

Partner laboratories of MINOS

IMEP-LAHC/CMNE ; CEA leti

Thesis overview: (10 lignes)

The advancement of 3D technologies with sequential integration brings new possibilities for mixed architectures with performances in both speed AND low consumption, that cannot be easily met with 3D "stacking" technologies. This is due to the fundamental property which differentiates this technology: the very close distance between the 2 (or more) layers. This introduces very small parasitic capacitances which allow digital signals to have a high frequency while at the same time being generated with a low energy. These high frequency signals, the spatial localization, the strong interconnection density and the possibility of having, mainly on the lower layer, analog circuits, make the analysis of noise generation and propagation, in our opinion, necessary to take into account as soon as possible. This thesis subject proposes to study in a detailed way the different electronic noises that could be generated and more importantly propagated in this 3D structure type. The goal of this work is to understand the phenomena and to model them in order to ensure the technology robustness, as well as the associated circuit designs.

Keywords: sequential 3D, FDSOI, robustness, noise, coupling, mixed circuit, DTCO

Workplan: (½ page)

The present PhD thesis work will be built on the expertise of 3 laboratories: leti/DCOS/ LICL for the sequential technology, leti/DACLE/L3i for the mixed circuits of CMOS imager type and IMEP-LAHC / CMNE for the study and characterization of noise.

Considering the CMOS imager as the principal case study, a mixed circuit by nature, this work will focus on the noise generation and its propagation between the two circuit layers.

All the MOSFET noise types will be studied, i.e. the low-frequency noise (1/f), the generation-recombination noise (Lorentzian), the random telegraph signal noise (RTN) and the thermal noise (white). Apart from the last one, all the other types of noise have an amplitude that increases with the reduction of the transistor surface and also with the defect density, two properties very important for the 3D structures. In addition, in the case of RTN, the sudden change in the current value between various levels in the time domain can compromise a pixel's stability. On top of that, the noise level variability between identical transistors is enhanced in nano-scale MOSFETs, leading to an important level of uncertainty regarding the pixel noise. The PhD student have the responsibility of characterizing all the fluctuation phenomena in low frequencies for the 3D sequential technologies, in order to be able to create compact models.

Concerning the integration, the PhD student will be involved in the progress of the sequential 3D lot, which is fabricated based on simple designs already integrated in a mask. He/she could therefore characterize sequential 3D pixels in the middle of his/her thesis. He/she will work on the design scaling laws so that the density and performance, mainly in terms of pixel noise, are optimized. He/she should especially propose innovative integrations, taking advantage of simulation tools such as Coventor (layout/ process/ parasitic RC) that are useful in the framework of Design-Technology Co-Optimisation (DTCO).

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