

# Simulating Selective and Non-Selective Epitaxy over Oxide Isolated Regions Using *ATHENA*

## 1.0 Introduction

In certain cases, most notably in modern bipolar and SiGe HBT structures, epitaxial steps are performed after the oxide isolation structures have been already created. Thus the initial surface prior to epitaxy may contain regions of crystalline silicon, polysilicon or insulators, usually silicon dioxide. In the case of LOCOS isolation, the surface is also non-planar. In such epitaxial cases, epitaxy can be divided into two general types:-

- (i) non selective epitaxy
- (ii) selective epitaxy

In the first case, silicon is deposited epitaxially onto any exposed crystalline surface, and polysilicon is deposited onto amorphous regions such as oxide isolation or regions where poly-silicon already exists.

In the second case, the use of selective chemistry increases the silicon layer seeding time on non crystalline surfaces to such an extent, that effectively silicon is only deposited epitaxially onto exposed crystalline surfaces. No polysilicon or amorphous silicon is deposited onto the oxide isolated regions.

In this article, the methodology for simulating both these scenarios is described.

## 2.0 Non Planar LOCOS Structure Example

In order to demonstrate the epitaxial capabilities, a standard LOCOS structure is used as the starting substrate, since this presents a surface that is both non planar and contains a combination of crystalline and non crystalline surfaces.

The structure prior to epitaxy is a simple LOCOS isolated active region as shown in Figure 1. Following a high temperature anneal to remove the native oxide, a typical *ATHENA* epitaxy statement would then be as follows:-

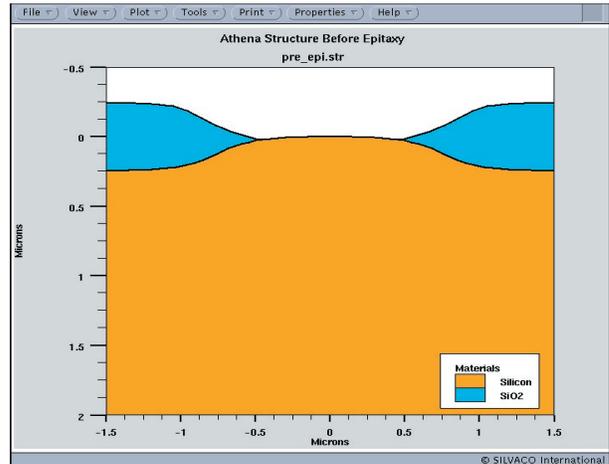


Figure 1 Structure Prior to Epitaxial Growth.

```
epitaxy time=1 temp=1000 thickness=0.2
divisions=8 c.boron=1e15 SI_TO_POLY
```

The key parameter in the *ATHENA* epitaxy statement that invokes the automated deposition of polysilicon on non crystalline regions of the device is "SI\_TO\_POLY". Other parameters such as c.boron=1e15 are simply inserted to emulate the un-intentional doping that occurs during epitaxy. Intentional doping can also be added using the same syntax format. After the Athena epitaxy statement above, the structure is now as shown in Figure 2.

Simulating selective epitaxy is now very simple because the epitaxial growth on the non crystalline regions is now polysilicon rather than silicon. Thus the simple statement

"etch poly all"

removes the poly silicon layer over the oxide leaving behind a structure as it would appear if selective epitaxy was used instead. After the etch above, the structure now appears as shown in Figure 3.

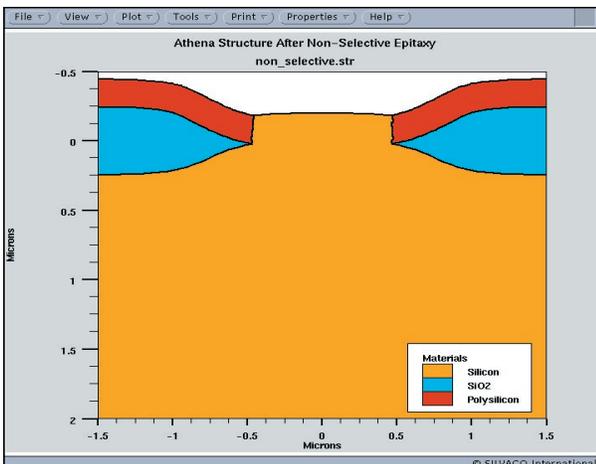


Figure 2 Structure After Non-Selective Epitaxial Growth.

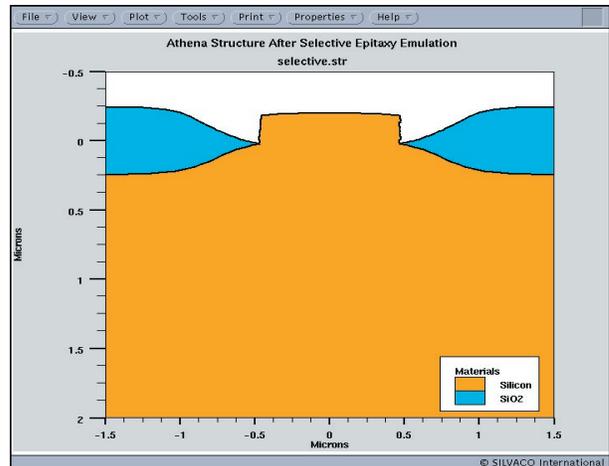


Figure 3 Structure After Emulating Selective Epitaxial Growth.