



EUROPRACTICE



## IHP 0.13 $\mu\text{m}$ IC, ELECTRONIC PIC, GRAPHENE PIC MULTI-PROJECT-WAFER PROTOTYPING

Europractice offers Multi-Project-Wafer (MPW) fabrication for IHP SiGe:C BiCMOS technologies, and Electronic and Graphene flavours of Photonic Integrated Circuits (PICs).

### Why Europractice?

- ▶ Affordable and easy access to Prototyping, Design Tools, and Training for universities, research institutes, and their spinouts.
- ▶ MPW runs for multiple technologies, including ASICs, Photonics, TFT, and more.
- ▶ Advanced packaging and system integration support.

### Why IHP?

- ▶ The world fastest Si-based RF-technologies and monolithic photonic BiCMOS solutions, providing integrated HBTs with cut-off frequencies of up to 500 GHz.
- ▶ Very small minimum block size (0.8 mm<sup>2</sup>) for MPW for all technologies.
- ▶ Open-Source IHP 130nm BiCMOS PDK for Analog/Digital, Mixed Signal and RF Designs with low-cost fabrication.

### Technology Highlights

#### 0.13 $\mu\text{m}$ SG13 & 0.25 $\mu\text{m}$ SG25

IHP offers research partners and customers worldwide access to its powerful SiGe:C BiCMOS technologies and special integrated RF modules. IHP technologies are based on 0.13 $\mu\text{m}$  / 0.25 $\mu\text{m}$  CMOS process. Several generations of high-speed SiGe Heterojunction Bipolar Transistors (HBT), passive components, such as poly resistors and MIM capacitors, have been developed and integrated in 0.25 $\mu\text{m}$  and 0.13 $\mu\text{m}$  BiCMOS technologies which are available for chip fabrication via IHP's MPW and prototyping service.

The 0.13 $\mu\text{m}$  BiCMOS process SG13G2 represents the fastest currently available SiGe HBT technology featuring peak  $f_t/f_{\text{max}}$  values of 300 GHz/500 GHz. These developments were based on a series of pioneering contributions to the development of SiGe HBTs including the introduction of carbon doping for stabilizing steep base doping profiles and new device constructions with reduced parasitic resistances and capacitance.

These IHP technologies are especially suited for applications in the higher GHz bands, e.g., for telecommunications & broadband (Gigabit WLAN, wireless sensor networks, wireless security solutions, fiber optic circuits), radar, medical imaging applications, aerospace, short-range detection for automotive, imaging sensor and motion recognition.

**SG13S** is a high-performance 0.13 $\mu\text{m}$  BiCMOS with npn-HBTs up to  $f_t/f_{\text{max}} = 250/300$  GHz, including CMOS logic.

**SG13G2** is a very high-performance 0.13 $\mu\text{m}$  BiCMOS technology with the same device portfolio as SG13S but with a much higher bipolar performance with  $f_t/f_{\text{max}} = 300/500$  GHz.

**Open Source PDK based on the SG13G2** technology for Analog/Digital, Mixed Signal and RF Designs.

**SG13G2Cu** and **SG13SCu** is a FEOL process SG13S and SG13G2 together with Cu BEOL option from X-FAB containing Copper and Aluminum layer.

**SG13G3Cu** is the highest performance HBT with up to 470GHz transit frequencies and up to 650 GHz maximum oscillation frequencies. The process offers an 8-layer Cu-BEOL from X-FAB.

**SG13G3** is the highest 0.13µm BiCMOS technology with the same device portfolio as G13G3Cu and with 7-layer Al-BEOL. This process option is only offered for research and prototyping purposes.

**TSV (Through Silicon Vias)** is an additional option in SG13S and SG13G2 technology, which offers RF grounding by vias through silicon to improve RF performance.

**LBE (The Localized Backside)** is offered to remove silicon locally to improve passive performance (available in all technologies).

**MEMRES** is a fully CMOS integrated memristive module based on resistive TiN / HfO<sub>2-x</sub> / TiN switching devices in the SG13G2 technology.

## Electronic Photonic Integrated Circuits

**SG25H7\_EPIC** is the monolithic integration of photonic devices, such as detectors and modulators, in the frontend of a Si-based integrated circuit technology that allows shortest possible interconnects between photonics and electronics, from which high-speed performance of Electronic-Photonic Integrated Circuits (EPIC) greatly benefits.

The PDK features include Luceda IPKISS support for photonic designs (including simulation using Caphe) and Cadence support for electronic – photonic circuit design (DRC, LVS, QRC).

This technology is especially suited for Optical Transceivers for 100G/200G/400 GHz applications.

## Graphene Photonic Integrated Circuits

200 mm silicon photonics wafer with integrated graphene PICs, developed under the GATEPOST project and 2D Pilot Line (2D-PL)—extending Si photonics with a graphene module.

## Technology Details

0.13µm SG13S	0.13µm SG13G2 BiCMOS/SG13CMOS	0.13µm SG13S Cu/G2Cu/G3Cu
<p>Bipolar:</p> <p>High-speed HBT</p> <p>Ft/Fmax/BVceo: 250 GHz/330 GHz/1.7V</p> <p>High-voltage HBT</p> <p>Ft/Fmax/BVceo: 40 GHz/120 GHz/3.7V</p> <p>CMOS logic:Vdd = 1.2V</p> <p>CMOS I/O: Vdd = 3.3V, 1.2V Core voltage</p> <p>Passives: Poly-Si resistors, MOS varactors, Inductors</p> <p>MIM Cap. 1,5 fF/ µm<sup>2</sup></p> <p>Interconnects:</p> <p>Backend offers 7 layers Al incl. 2 &amp; 3 µm layers</p>	<p>Bipolar:</p> <p>High-speed HBT</p> <p>Ft/Fmax/BVceo: 300 GHz/500 GHz/1.6V</p> <p>High-voltage HBT</p> <p>Ft/Fmax/BVceo: 120 GHz/330 GHz/2.5V</p> <p>CMOS logic:Vdd = 1.2V</p> <p>CMOS I/O:Vdd = 3.3V, 1.2V Core voltage</p> <p>Passives: Poly-Si resistors, MOS varactors, Inductors</p> <p>MIM Cap. 1,5 fF/ µm<sup>2</sup></p> <p>Interconnects:</p> <p>Backend offers 7 layers Al incl. 2 &amp; 3 µm layers</p>	<p>IHP SG13S/G2 FEOL device performance and XFab Cu BEOL</p> <p>MIM Cap. 2,1 fF/ µm<sup>2</sup></p> <p>Interconnects:</p> <p>Backend offers 8 layers:</p> <p>6 layers Cu: 4 thin, 2 thick plus</p> <p>2 Al top metal layers</p> <p>6-layer Cu and 2-layer Al option from X-FAB</p>
0.13µm SG13G3	0.25µm SG25H7_EPIC	Graphene PIC
<p>BiCMOS technology with very high bipolar performance</p> <p>fT= 470 GHz, fmax = 650 GHz</p> <p>Thin gate oxide for the 1.2V and a thick oxid for a 3.3V supply voltage</p> <p>Temp. range: -40° C. / +125° C</p> <p>BiPolar&amp; CMOS devices, 1,5 fF/µm MIM capacitor, HRES</p> <p>FEOL process SG13G3Cu</p> <p>Backend offers 7 layers Al incl. 2 &amp; 3 µm layers</p>	<p>High-performance BiCMOS process with Photonic devices.</p> <p>fT= 220 GHz</p> <p>fmax = 290 GHz</p> <p>High-Res</p> <p>Ge photodiodes</p> <p>3 thin + 2 thick Al-BEOL layer stack</p>	<p>Substrate</p> <p>Material: Silicon; Waveguide: Silicon Nitride</p> <p>Included modules:</p> <p>Contact module</p> <p>Waveguide module</p> <p>Coupler modules</p> <p>Graphene Module</p> <p>Encapsulation module</p> <p>Cladding modules</p>

