Flexible Hybrid Systems: High Performance CMOS with Printed Electronics

Defense Manufacturing Conference
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Rich Chaney
Flexible Hybrid System

What is that?

Printed Electronics
Low Cost, R2R, Large Format

Flexible Hybrid System
“Combination of flexible printed materials and flexible silicon-based ICs to create a new class of flexible electronics.”

Flexible ICs
High Performance, High Density

Fly-by-Feel:
Conformal
Structural Integration
Performance
Ruggedness
Durability
Flexible Hybrid System Application
Conformal Load Bearing Antenna Structure

AFRL/RBSA
CLAS Phase I SBIR
FA8650-12-M-3219

CLAS: Airframe Integration

CLAS: Antenna Integration in Structural Composite

Flexible Reconfigurable Antenna

Traditional ICs
SMA Connector

Pressure Sensor
Strain Gauge
Antenna
LNA
ADC µCtrl

Data Bus

CLAS: Antenna Integration

Ground Plane
Left Configurable Array
Center Array
Right Configurable Array
Flexible Hybrid System
Concept to Product

IC Design → IC Fabrication → IC FleX → Flexible Hybrid Integration

Printed Circuits & Sensor Design → Printed Electronics Fabrication
**FleX™ Silicon-On-Polymer Roadmap**

- **Today**
  - Functional Devices
  - Initial Production
  - Volume Production

- **FleX Development**
  - Functional CMOS
  - Process Qualification

- **ASi SOI CMOS**
  - Electrical Testing
  - Functional CMOS
  - TRL7

- **Jazz CS18**
  - Proof-of-Concept
  - Electrical Testing
  - TRL6

- **Next Foundry Process**
  - Electrical Testing
  - Process Qualification
  - TRL4

**FleX: Transparently Thin Functional CMOS**
FleX Option for Jazz CS18

Jazz CS18-FleX is the industry’s first commercially available flexible CMOS foundry process

Characterization of CS18 in FleX is underway

First wafers show excellent mechanical properties

DC data pre- and post-FleX show no shift in transistor performance

RF pre- and post-FleX evaluation underway

Initial characterization data will provide a preliminary CS18-FleX PDK

Announced at TowerJazz Technical Global Symposium Oct 31, 2012

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American Semiconductor Inc.
Flexible Hybrid System
Concept to Product

IC Design → IC Fabrication → IC FleX

Flexible Hybrid Integration

Printed Circuits & Sensor Design → Printed Electronics Fabrication
Flexible Hybrid System
Development & Prototype Capability

American Semiconductor Boise has developed capability for flexible die attach and direct write of flexible interconnects.

This manual capability provides a basis for high volume automated assembly.

The first demonstration of flexible die attach and interconnects in harsh environments was made in June 2012. A FleX IC was successfully tested as part of a NASA payload by the RockSat Team from Idaho’s NNU, sponsored by American Semiconductor.
Flexible Hybrid System integration using roll-to-roll R2R capability

- Conductor
- Insulator
- Simple Display
- Power
- Transistors

Cure

FleX Die on Reel

50 – 500 Ft/min

Flex IC Stamp or Smart Sensor Integrated in Roll-to-Roll Line

(Automation Concept)
Flexible Hybrid System
Concept to Product

IC Design
- You
- American Semiconductor
- Others

IC Fabrication
- Jazz
- American Semiconductor
- Others

IC FleX
- American Semiconductor

Printed Circuits & Sensor Design
- You
- American Semiconductor
- Others

Printed Electronics Fabrication
- Soligie
- American Semiconductor
- Others

Flexible Hybrid Integration

Pressure Sensor
Strain Gauge
LNA
ADC µCtrl
Antenna
Flexible Hybrid Systems
Example Applications

Implantable Medical

Secure Documents & Financial

Smart Labels

Surgical

Wearable Medical

Conformal Antennas
Load Bearing Antennas
Fly-by-Feel

U. Illinois / MC10 Inc. Image

BodyMedia Image

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Flexible Electronic Products and Services Provider

Corporate Headquarters – Boise, ID
- Engineering – Design, Process, Modeling
- FleX™ Silicon-on-Polymer™ mfg and assembly
- Test & Characterization Cleanroom
- Sales, Marketing, Administration

- Process engineering center – Santa Clara, CA
- Manufacturing – pilot SoP operations

Small Business
Privately Held
Founded November, 2001

Product Lines
- FleX – Silicon-on-Polymer™ (Flexible Electronics)
- Design Services – Turnkey Design Solutions

ITAR Compliant
Thank You