Corporate Headquarters – Boise, Idaho, USA
- 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 ICs)
- Design Services – Turnkey Design Solutions
FleX Silicon-on-Polymer (SoP) provides the flexible solution we need TODAY.

- SoP – Single crystalline high mobility
- FLEXIBLE High performance CMOS
- High density, low power logic
- High density memory
- High speed communications

Currently Available chipset:
- MCU
- ADC
- RFIC

- Manufacturing Infrastructure
Feb 2014 Announcement at Flextech

- Tested before and after FleX processing
- Tests passing at up to 12MHz (limited by test environment, not silicon)
- ~2.2M transistors
- Over 275,000 passing digital test vectors

<table>
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<tr>
<th>Block</th>
<th>Full Thickness</th>
<th>FleX Wafer</th>
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<td>CPU - Opcodes</td>
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<td>CPU - ALU</td>
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<td>RAM - 8KB</td>
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<td>ROM - 1KB</td>
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<td>I/O Ports</td>
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<td>Comm Peripherals</td>
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<td>Timers / Counters</td>
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FleX™ Silicon-on-Polymer™
and Flexible Hybrid Systems

FleX ICs
High Performance, High Density
Physically Flexible Silicon

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

FleX™ IC Product Roadmap

- FleX-MCU™: adds NVM
- FleX-NVM™: Non-Volatile Memory
- FleX-LNA™: standalone Low Noise Amplifier
- FleX-MCU™: adds 8-bit ADC and RFID 915MHz transmitter
- FleX-ADC™: standalone 8-bit Analog-to-Digital Converter
- FleX-RFIC™: standalone 915MHz RF transmitter
- FleX-ASIC: custom ICs

FleX-MCU™: 8-bit RISC, 1.2V core, 2.5V I/O, UART, I2C, SPI

Printed Electronics
Low Cost, R2R, Large Format

CMOSETR 2014
Flexible Hybrid System
“Combination of flexible printed materials and flexible silicon-based ICs to create a new class of flexible electronics.”

Printed Electronics
Low Cost, R2R, Large Format

Smart Cards:
SIM/PIV/CIV
Identity
Finance
Contacted
Contactless

Consumer:
Tablets
Phones
eReader
Ultra-thin
Flexible

Flexible Fex ICs
High Performance, High Density

Fly-by-Feel:
Conformal
Structural
Antenna
Sensors
Ruggedness
Durability

CMOSETR 2014
Our greatest industry challenge: Creating & introducing successful products

- Flexible product development programs are critical
  - Commercial Businesses
  - Research Institutions and Universities
  - Government
- Low cost flexible electronics platform technology must be available
- A total system solution is required
  - Proven technology that meets product requirements
  - Technology that is “mature enough”
  - Technology supported by manufacturing
- Necessary technology is not available today, but we are getting closer...
- Development Kits can provide product designers the necessary platform
- Kit development and availability will be covered in this presentation
Flexible Hybrid Process Integration

- IC Design
- IC Fabrication
- IC FleX SoP Conversion
- Printed Circuits & Sensor Design
- Printed Electronics Fabrication

Current Focus
- FleX-MCU™
- FleX-ADC™
- FleX-RFIC™
- FHS Assembly (2014)

Development to meet FHS Technology Roadmap
- Printed electronics capacity and FleX IC Fabrication are well established
- Current state-of-the-art development is focused on FHS assembly
- Assembly:
  - FHS Design methods and tools
  - FleX Die singulation and handling
  - Die Attach and connect
  - Encapsulation

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PRODUCTS are what our industry needs
Products require concept demonstrations
Capability is needed to enable product development

New Technology: FleXform

FleXform is a kit platform for product developers

FleXForm: Flexible development hardware
- FleX-MCU on a flexible demo board
- Standard connectors for interfacing to PC and prototyping boards
- Flexible, printed display and buttons
- Voltage regulators
- Serial EEPROM

FleXform: Software & Documentation
- C-compiler and assembler
- Product specifications
- User’s guide
- Data sheet
- Demonstration software
User prints or applies flexible sensors and/or displays.

User Flexible Display Region

Connections to printed pads made by user or ASI.

User makes connections to/from user device to existing printed pads.

FleX-MCU
5mm x 5mm
8-bit RISC CPU
8KB SRAM, 2KB ROM
UART, SPI, I2C
18 I/O – 2.5V CMOS

FleXform™ Development Kit

Available Dec. 2014

Prototyping Board
PC interface
EEPROM for User Code
Voltage Regulators

Software and Documentation
C-compiler & Assembler
EEPROM Programming
User's Guide & Specifications

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Recent HYBRID Research and Development Efforts

• **Karl Ronka** – Finland (LOPEC May 2014)
  - Bare Die and QFN (3mm x 3mm) on PET with ACA
  - R2R rotary screen print
  - “More study needed

• **Mike Clausen** – UK (LOPEC May 2014)
  - Pick and Place with conductive adhesive
  - Integrated Smart System (ISS) – “TRL2”

• **Marc Koetse** – Netherlands (LOPEC May 2014)
  - “Print where possible, use Si or Cu where needed”
American Semiconductor Integration

- **Semiconductor IC – FleX SoP**  
  (Mechanical Die used for development)
- **Printed Substrate - PET**

- **FHS – Die Attach**
  - Challenge: Full adhesion with ≤ 75um alignment tolerance

- **FHS – Die Connect**
  - Challenge: Pitch ≤ 260um, Min Feature ≤ 130um  
  Pad Up (Conductive Adhesive)  
  Flip Chip (ACA)

ACA – *Anisotropic Conductive Adhesive*
ASl Rainbow™ FCB Test Coupon with MEC Die

- Pad-up Configuration
  - Resistance measurement from point1 to point2 is ~30Ω
  - Resistance of substrate traces from edge to near the mechanical die are 14-15Ω (red/blue)
  - Resistance of die region (green) which consists of two pad-to-trace interconnects and a printed trace on the mechanical die, are in the 0.2-1.5Ω range
  - Resistance between adjacent traces are >10MEGΩ

- Flip-chip Configuration
  - Die region on flip-chip board consists of two pad-to-trace contacts made with anisotropic ink/paste and a printed trace on the mechanical die; this (green) section has a resistance of 0.2-1.5Ω
  - Resistance between adjacent traces are >10MEGΩ
Flip-chip
Pad-up
Purpose: Assembly Technology Development (demonstrate FHS manufacturing)

BOM:
- FleX test die
- FleX-MCU – flexible IC
- Flexible printed circuits
- Rainbow demonstrator

Rainbow Demonstrator:
- Development tool
- Fully flexible demonstration
- Electrical verification of assembly methods
- Verification/demonstration of MCU capability

Rainbow demonstrator for Flexible Hybrid System (FHS) demonstration of FleX-MCU™

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Thank You