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Integration of Ultra Low Power Sensors in RFID Systems: A Flexible Tag Microlab for Logistics Applications

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Content

Integration of Ultra Low Power Sensors in RFID Systems:

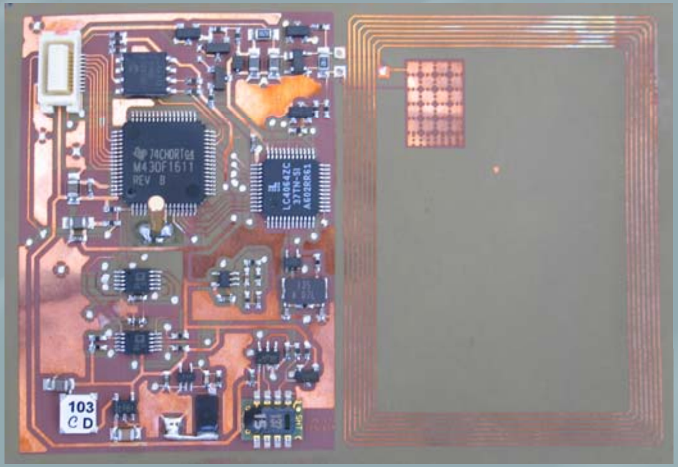
A Flexible Tag Microlab for Logistics Applications

- Background information
- Target applications
- Technological challenges and objectives
- Technological results
- Current technological limitations
- Recommendations and future needs

Background Information

- Objectives:
  - Sensor system with RFID communication
  - Tracking and tracing of goods

- Challenges:
  - Power consumption of sensors, especially gas sensors
  - Reliable integration and packaging into flexible substrates



Target Applications

- Logistics
  - Food
  - Pharmaceuticals
  - Machinery
  - High priced products
  - Safety (fire & hazard detection)

- Security
  - Burglary
  - Terrorism

| Change edition

BBC NEWS UK EDITION

Last Updated: Sunday, 29 August, 2004, 07:16 GMT 08:16 UK

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Bomb traces in both Russian jets

Traces of explosive have now been found in the wreckage of both passenger jets which crashed earlier this week, Russian investigators say.

The two Tupolev airliners crashed almost simultaneously on Tuesday in southern Russia, hundreds of miles apart, killing 89 passengers and crew.

In both cases debris was scattered over a wide area

The FSB security service had already announced the discovery of traces of hexogen among the remains of one jet.

Now it says the explosive has been found in the remains of the other.

After finding explosives traces on one plane, a Sibir Airlines Tu-154, on Friday, Russian officials described what had happened as a terrorist attack.

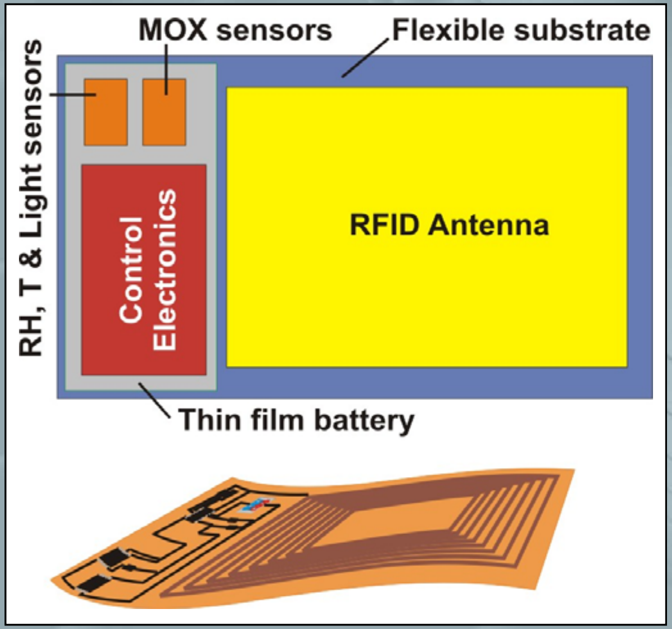
They also said the pilot had sent out a hijack alert just before the plane crashed, Russian media report.

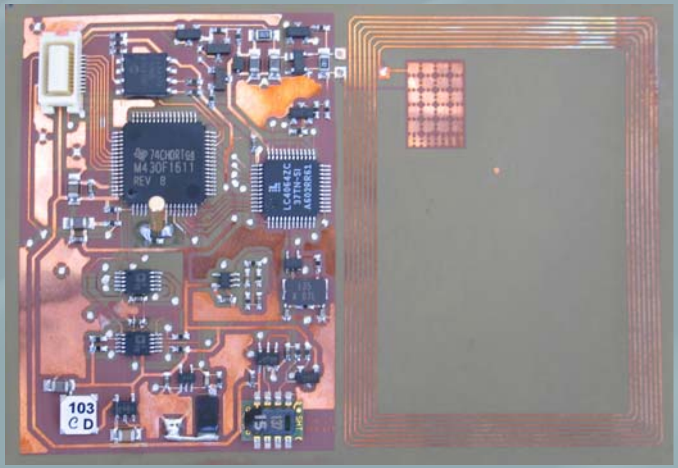
FSB spokesman Sergei Ignachenko said on Saturday: "Additional examination of the fragments of the Tu-134 aircraft which crashed on Tuesday... has revealed traces of hexogen."

Technological Objectives

Integration of ultra low power sensors in RFID systems

- Gas sensors
- Temperature sensor
- Light sensor
- Humidity sensor
- RFID communication
- µProcessor based
- Protocols





Technological Challenges

Enabling technologies explored:

- Realisation of ultra low power (ULP) hotplates
- Micro drop coated sensing layer with nano sized particles
- Reliable packaging for gas sensors
- Development of power saving measurement routines
- Dye based light sensor/solar cell using polymer technology

Technological Challenges

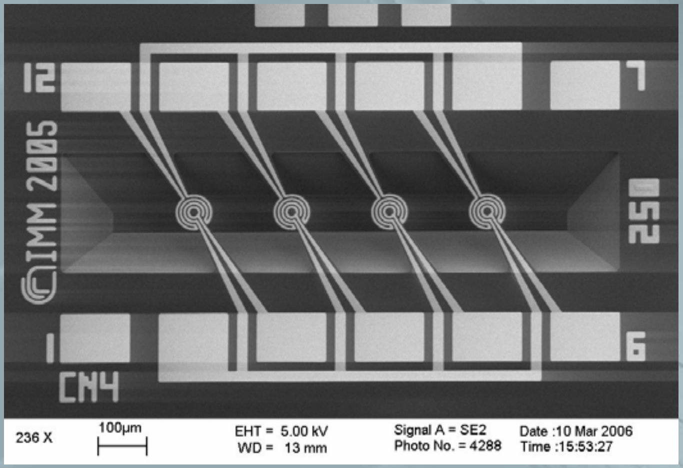
Supporting technologies required:

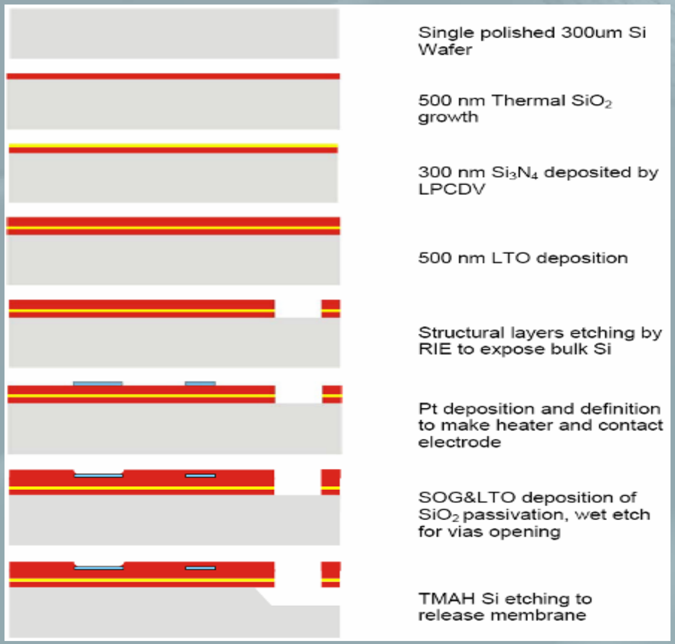
- Integration processes for flexible substrates
- Advanced µProcessor with different sleep modes
- Proprietary protocols
- Microsystem technologies

Technological Results

Realisation of ultra low power (ULP) hotplates

- 4 micro-hotplates with 1.0mm x 1.5mm die footprint
- 8.9 mW at continuous 400°C
- 50 μm diameter, circular active area
- SiO2/Si3N4/SiO2 membrane with Pt heater

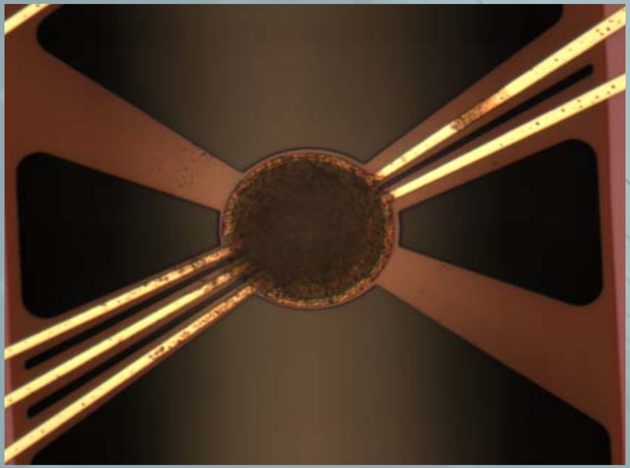




Technological Results

Micro drop coated sensing layer with nano sized particles

- Nano powders of SnO_2 or WO_3 + 1% Pd or Pt diluted in glycerol
- Drop coating using a micro-injector
- As-deposited films annealed in-situ at 480 ºC for 2 hours



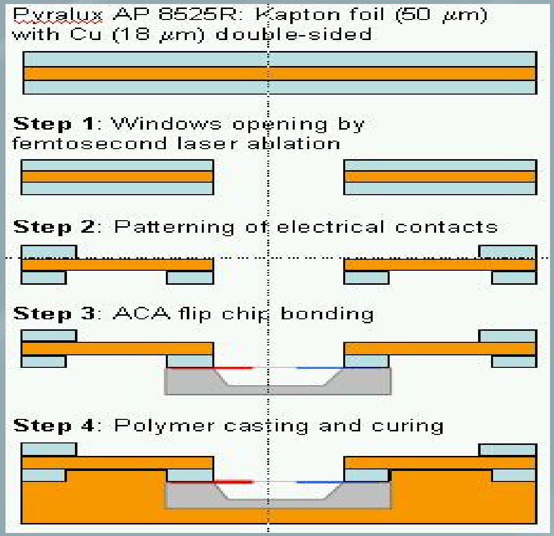
Sensors→ Data set↓	A	B	C	D
312 s	66.66	88.33	86.66	73.33
156 s	71.66	88.33	86.66	81.66
78 s	70	83.33	83.33	73.33
39 s	81.66	78.33	61.66	68.33

Success rate in gas semi-quantification (%)

Technological Results

Reliable integration and packaging of gas sensors

- Gas sensors need access to the environment
- Flip chip bonding with anisotropic conductive adhesives
- Robust packaging by polymer casting and curing



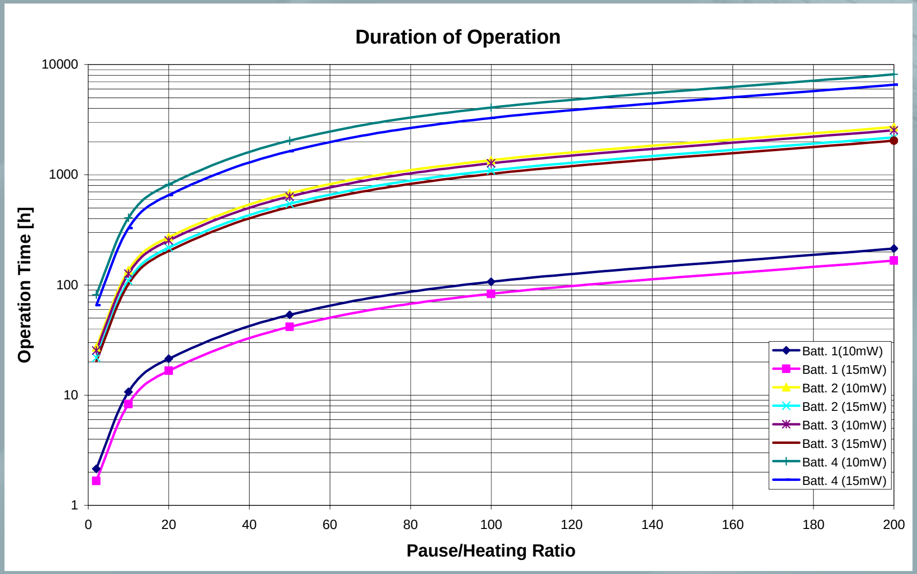
Technological Results

Development of power saving measurement routines

- Discontinuous mode of operation for MOX gas sensors demonstrated
- Successfully combined with suitable data processing methods
- Several days of operation possible using thin film batteries

Heating Time (AM)	Pause Time (LMP4)	Active Time per hour	Pause/Heating Ratio
5 s	10 s	1800 s	2
1 s	10 s	360 s	10
0,5 s	10 s	180 s	20
0,2 s	10 s	36 s	50
0,1 s	10 s	18 s	100
0,05 s	10 s	9 s	200

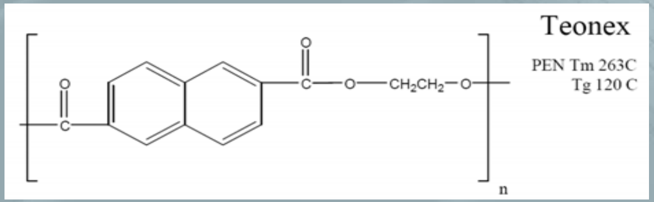
Manufacturer	Product Nr.	Voltage [V]	Capacity [mAh]	Dimensions [TxLxW]mm³	Rechargeable
VARTA	LPF25	3	25	0.44 x 22 x 29	NO
VARTA	LPP402934E	3.7	300	4 x 34.2 x 29.2	YES
HyperBattery	9-xx3438	3.7	280	2.5 x 38 x 34	YES
HyperBattery	19-xx5060	3.7	900	3 x 60 x 50	YES

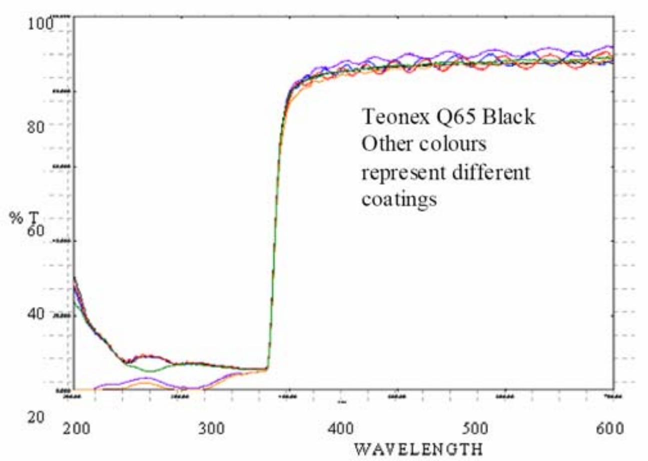


Technological Results

Dye based light sensor/solar cell using polymer technology

- Ruthenium as dye material
- Teonex by DuPont as substrate instead of Kapton
- Iodolyte as electrolyte, gelatinised with silicic acid
- Electrolyte replacement with Baytron P (PEDOT/PSS)





Current Technological Limitations

- MST process flow limitations for thermally stressed components
- Limited sensitivity of chemical sensing layers
- Fully flexible solutions are limited by stiff components
- Power consumption of components

Recommendations and Future Needs

- Reliable ‘submicron’ MST solutions
- Taylor made sensing layers using ‘nano-bio’ approach
- Research on conductive and semiconductive polymers and ‘nano-supported’ polymers for packaging
- Power harvesting methods

Acknowledgement

For the excellent scientific and engineering work and the close collaboration to the project partners of the

- EU IP GoodFood and the
- BMBF project TRACK

Special thanks to the European Commission and the Organisers of the HLC