New Radio-Frequency resonators based on Periodically Poled Lithium Niobate thin film and ridge structures

F. Bassignot¹, F. Henrot², L. Gauthier-Manuel³, B. Guichardaz², H. Maillotte², G. Haye¹, S. Ballardras³, E. Courjon³, J.M. Lesage⁴

¹FEMTO-Engineering, Technological developments center, 25000 Besançon, France
²FEMTO-ST, UM1 CNRS-UCF-ENSMM-UTBM, 25000 Besançon, France
³FrescNy Sys SASU, 18 rue Alain Savary, 25000 Besançon, France
⁴CELA, DGA, 35000 Rennes, France

Periodically Poled Lithium Niobate (PPLN) for RF applications

**PPLN principle**

Classical IDTs based transducer

Periodically Polled Transducer (PPT)
- Reduced TCF ~ Silicon TCF ~
- Robust (no short-circuit)
- High phase velocity wave (c > 10 000 m/s)
- High frequency twice higher

**PPLN fabrication**

Electric-field poling at room temperature

Specifications
- Water size: 3 or 4 inch
- Water thickness: 250 µm – 500 µm
- Bonded materials: CLN, CLT, Quartz, Sapphire...
- Bonded surface > 98%
- Traction bond > 25 MPa

**PPLN RF characterizations**

PPLN Transducer specifications
- 2 contributions:
  - Elliptical mode (c=3800 m/s)
  - Longitudinal mode (c=6500 m/s)
- TCF ~ -80 ppm/K
- k² < 1%
- Operating frequency: 5 MHz – 1.3 GHz

**PPLN thin film resonator**

Gold bonding by compression at room-temperature
- Water bond: 3 or 4 inch
- Bonded materials: Si, LiNbO₃, glass, quartz, Sapphire...
- Bonded surface > 98%
- Traction bond > 25 MPa

**RF characterization**

Si/PPLN transducer (50µm-period, 20µm-thick)/Si
- φ = 5600 m/s
- Qₘₚ ≈ 1000
- k² = 0.85%
- Phase rotation = 10°

**PPLN ridge resonator**

Home-made ridge dicing
- Cut materials: LiNbO₃, LiTaO₃, Si
- Roughness: < 5 nm
- Max. aspect ratio: 400

**RF Characterization**

PPLN ridge transducer (50µm-period, 20µm-wide, 250µm-deep)

- Shear wave φ = 8380 m/s
- k² = 19%

**Conclusion**

Acknowledgement: This work was supported by the DGA and is supported by the “Labex ACTION”, the “Conseil régional de Franche-Comté”, “FEMTO-Engineering” and partly supported by the French RENATECH network and its FEMTO-ST technological facility.

Contact: florent.bassignot@femto-st.fr

FEMTO Engineering
15 B avenue des Montboucours
25030 BESANÇON CEDEX
www.femto-engineering.fr