

# GaN RF Market Analysis

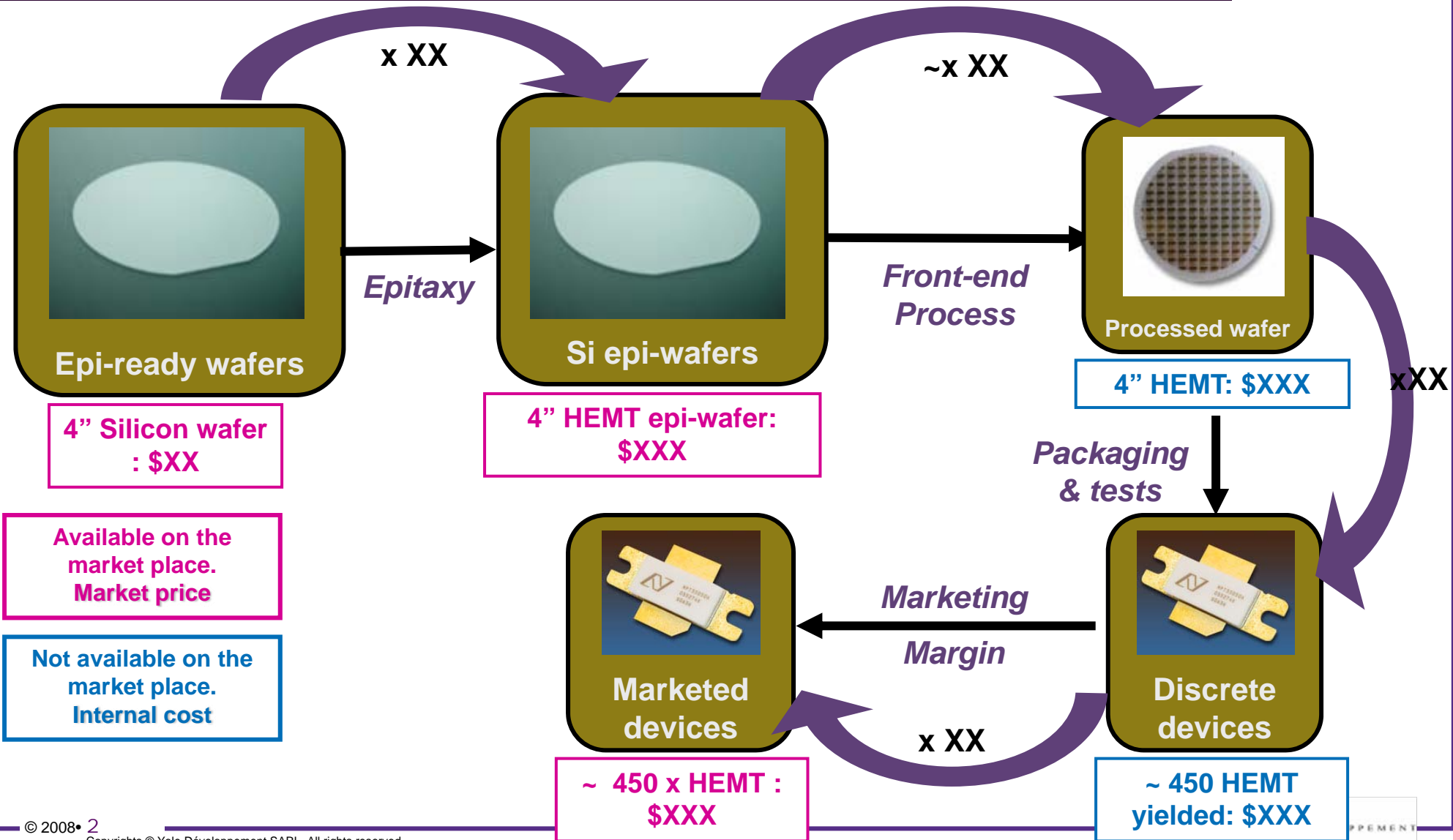
*Applications, players, devices & substrates 2005-2012*



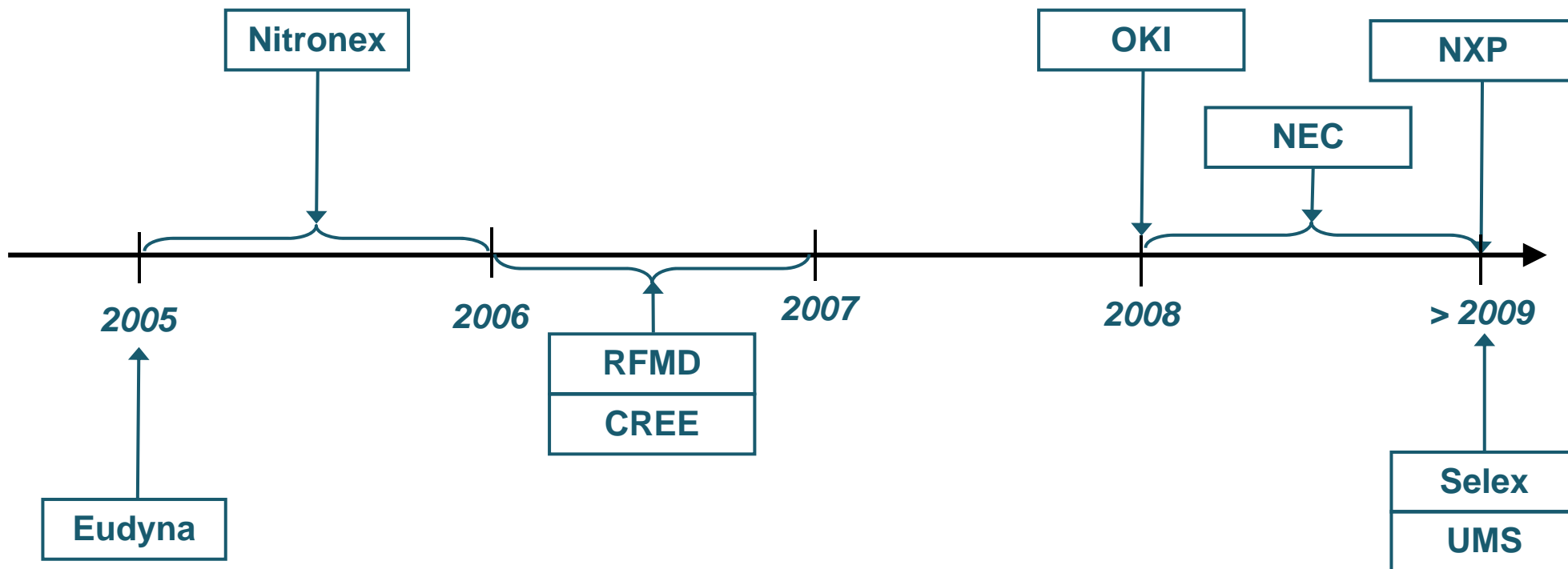
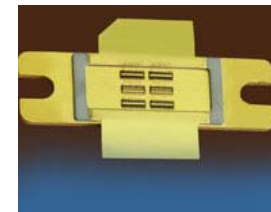
YOLE DÉVELOPPEMENT

45 rue Sainte Geneviève, F-69006 Lyon, France  
Tel : +33 472 83 01 80 - Fax : +33 472 83 01 83  
Web: <http://www.yole.fr>

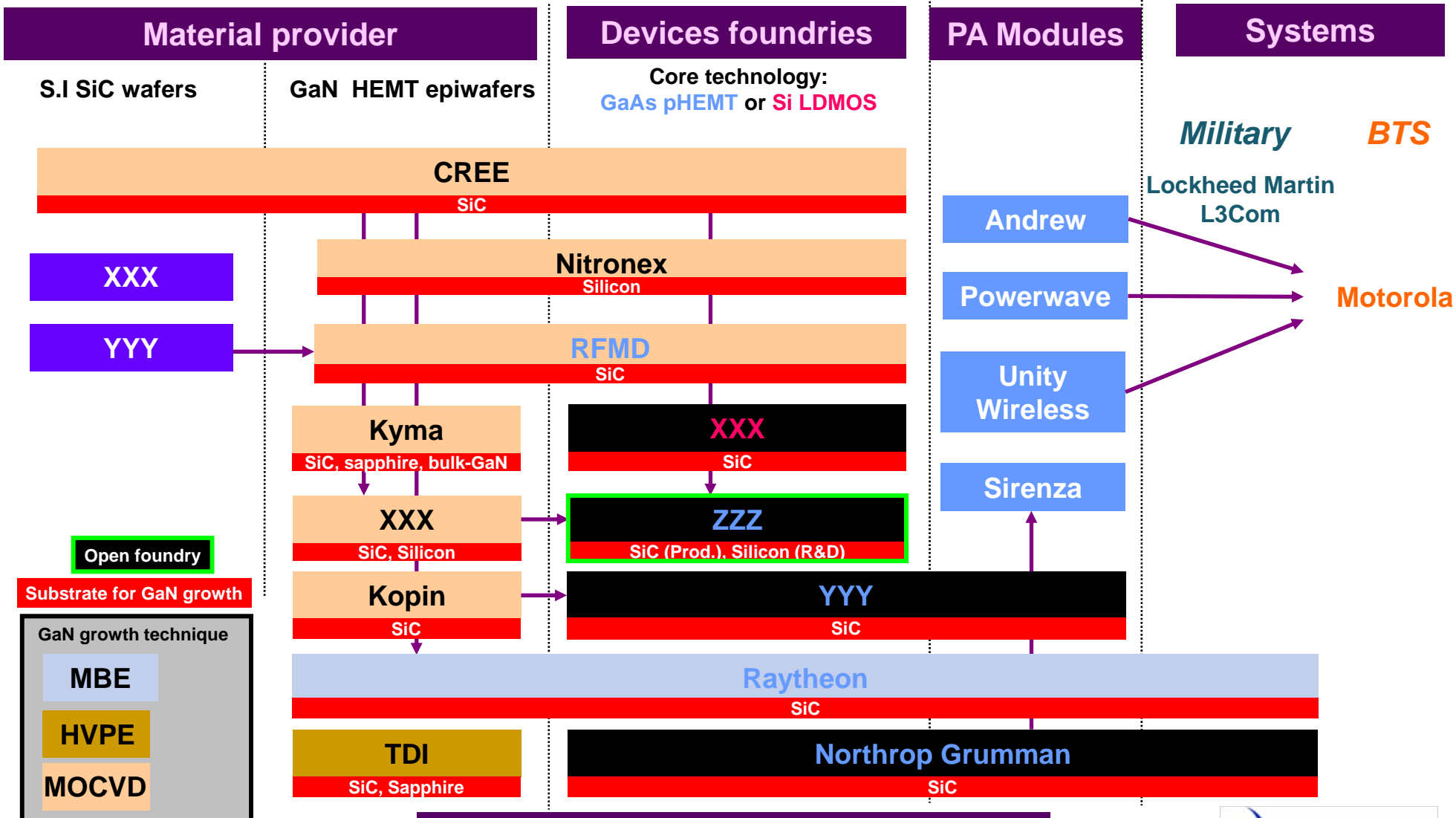
# Cost breakdown of HEMT process: from substrate to marketed devices GaN/Si (4")



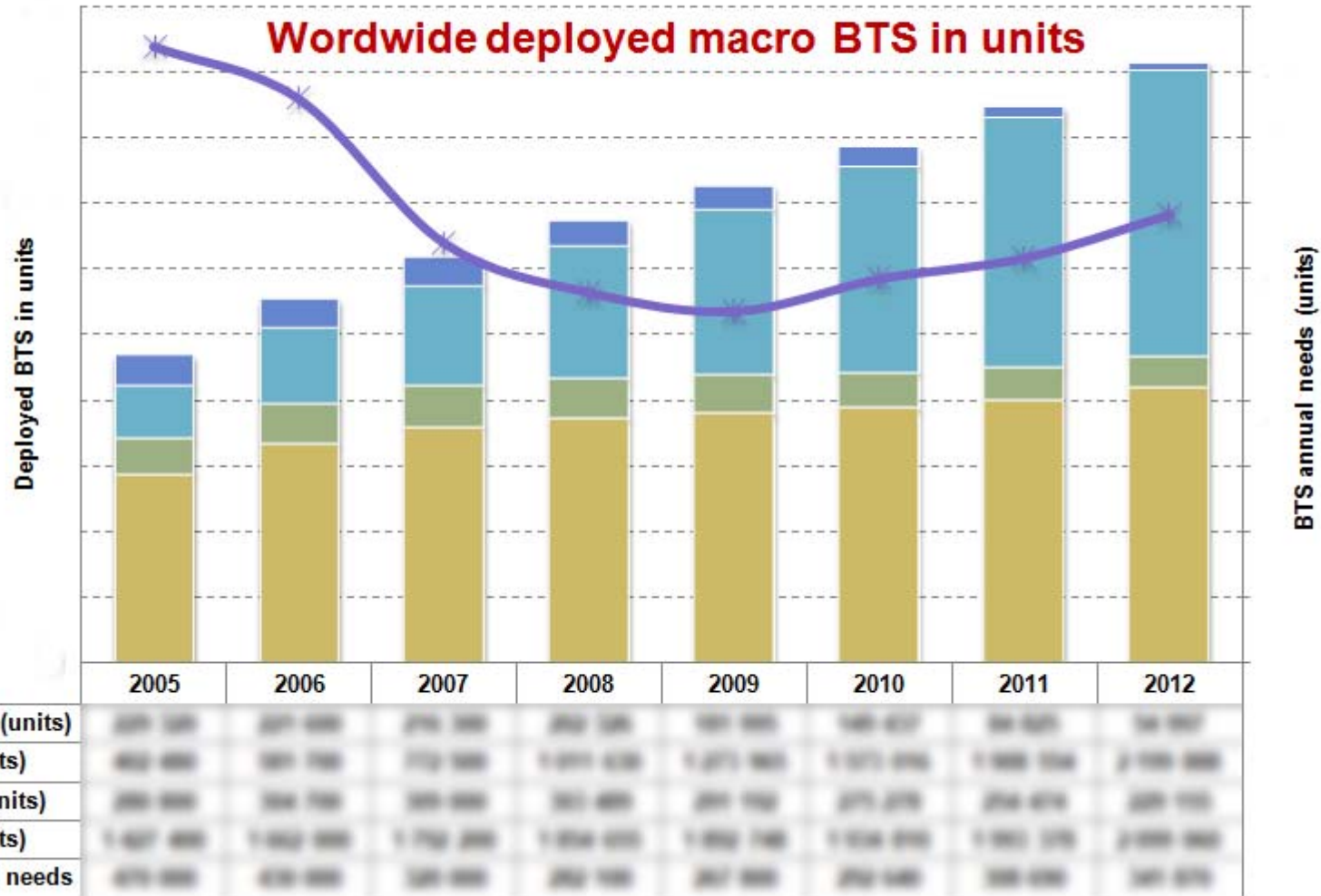
# GaN FET commercialization status & announcements



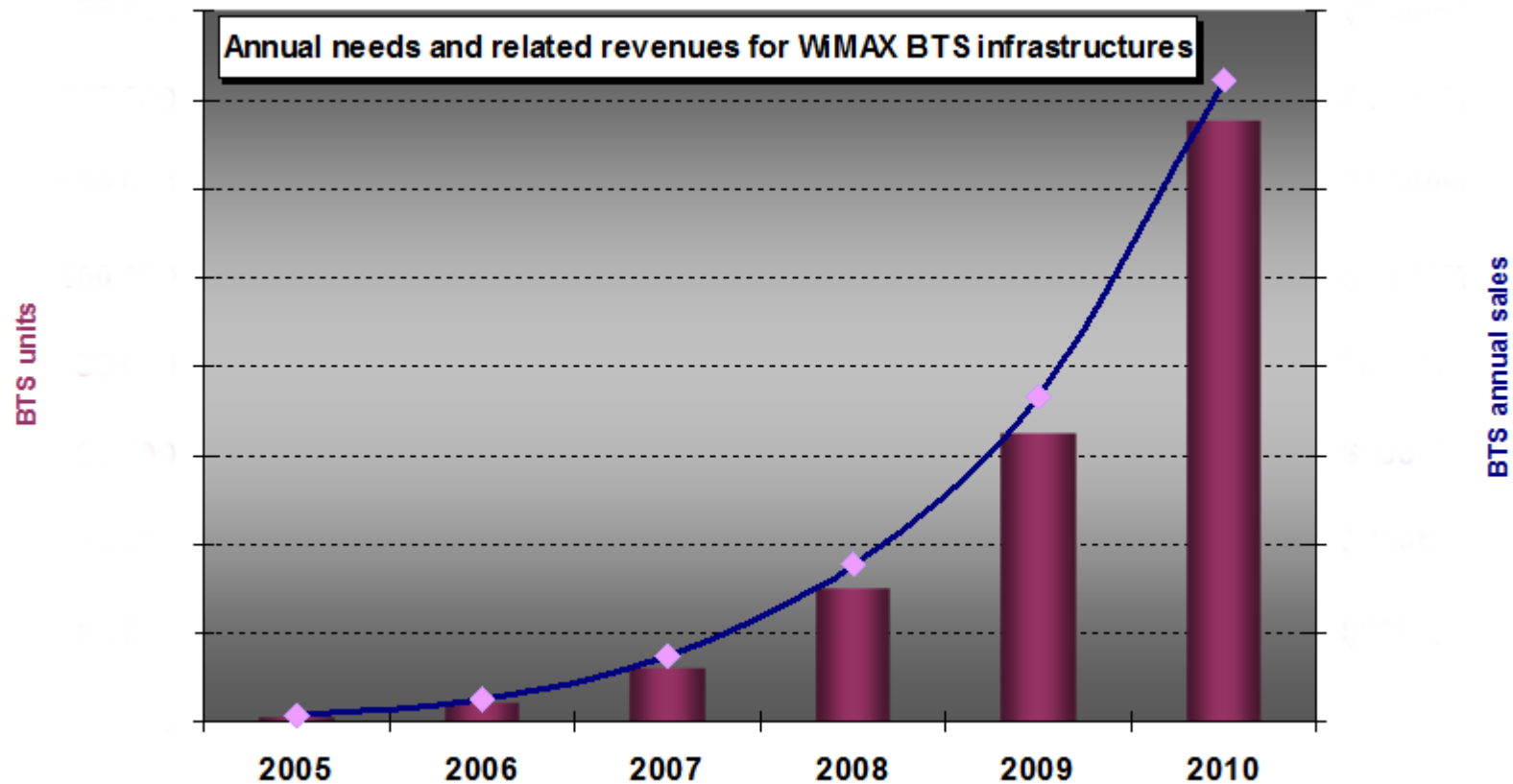
# RF GaN Industrial supply-chain in the US



# Worldwide deployed macro cellular base-stations 2005-2012 by standards



# 2005-2010 worldwide annual volumes and related revenues for WiMAX BTS infrastructures



	2005	2006	2007	2008	2009	2010
Annual needs for WiMAX BTS (units)	1,000	4,000	12,000	20,000	45,000	135,000
WiMAX BTS ASP (\$)	\$1,000	\$1,200	\$1,167	\$1,175	\$1,178	\$1,037
WiMAX BTS market (M\$)	\$1,000	\$1,200	\$1,400	\$1,700	\$1,700	\$1,400

# 2005-2012 S.I. SiC substrates price evolution for various diameters



**Average Selling Price for med-large volume orders:  
> 50 W/month for S.I.**

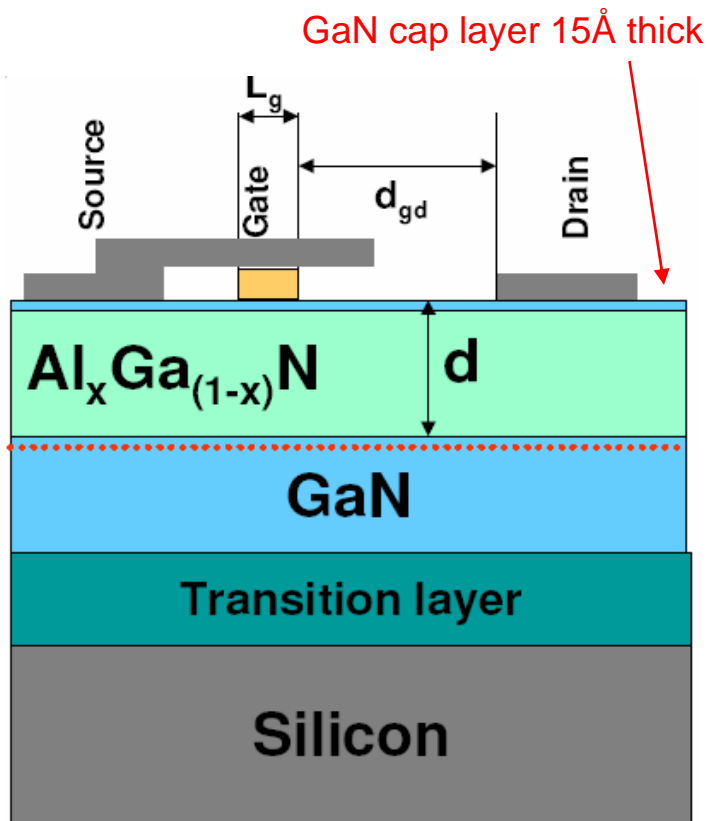
# Nitronex

## Devices structure & Process



- AlGa<sub>x</sub>N/GaN grown by MOCVD on high resistivity Si (111), with a barrier layer comprised of 20% AlN mole fraction.

NRF1 process platform full qualified on sept 2006



- Gate length = 0.5  $\mu m$
- Gate-Drain Spacing = 3  $\mu m$
- AlGa<sub>x</sub>N thickness = 180Å
- Semi-insulating GaN buffer layer 0.8 $\mu m$  thick
- Source: field plate employed
- 100mm (111) high resistivity silicon for substrate
- Ti/Al (Source: & drain)-Ni/Au (gate) ohmic contacts formed by use of RTA
- SiN passivation deposited by PECVD
- Ti/Au metallization
- 2D gas characteristics:
  - $n = 7 \cdot 10^{12} cm^{-2}$  (e density)
  - $m = 1300 cm^2/V$  (mobility)

Source: ROCS 2006

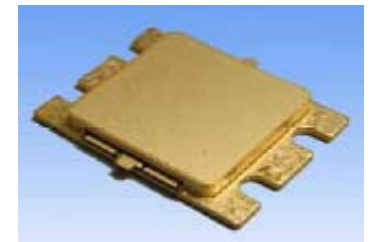
## Product characteristics

- OKI's products are actually under qualification of their customer. Milestones: Engineer Sample (ES) from the end of 2007 and production starting from 2008
- OKI is targeting the civil use applications such as for 3G and WiMAX.

Part No.*	Output Power P3dB (3dB compression) (typ.)	Power Gain G p (typ.)	Supply Voltage Vds (typ.)
KGF7201	47dBm(50W)	16 dB	50V
KGF7251	50dBm(100W)	15 dB	50V
KGF7252	53dBm(200W)	14 dB	50V



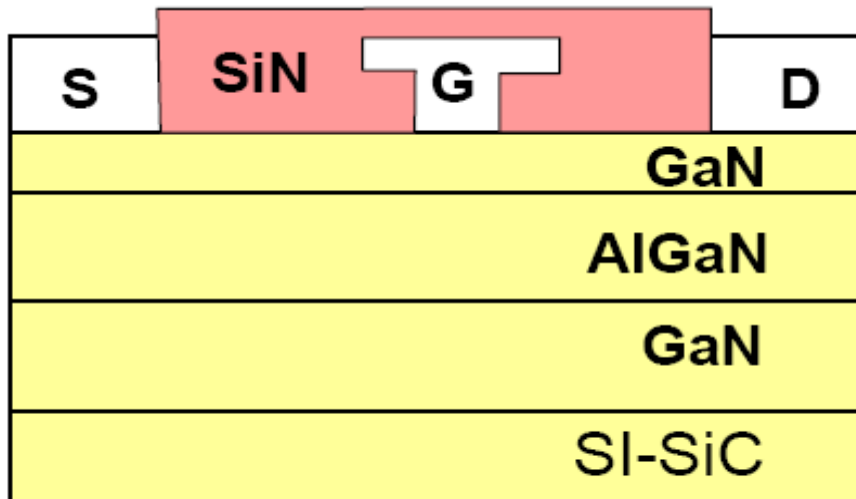
Packaging for KGF7201



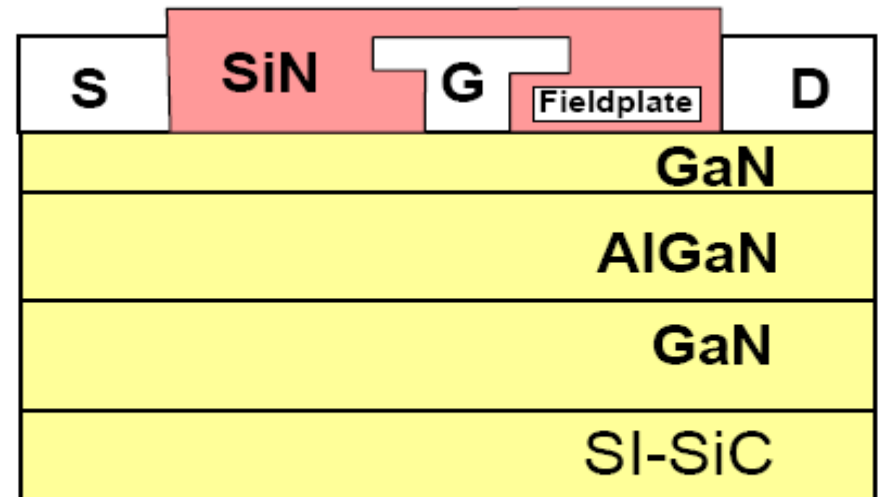
Packaging for KGF7251  
& KGF7252

## Device structure

- GaN on semi insulating SiC (up to 4 inch)
- 0.5  $\mu\text{m}$  GaN HEMT semiconductor process
- Ti/Al/Ni/Au ohmic contact
- SiN passivation
- Ni/Au Gate with Field Plate



28V 'step-gate' Device



48V AFP Device