# *POLYMER ELECTRONICS:*

## *a rapidly growing market*

*Bill Eccleston*

*Molecular Electronics Group, Liverpool University*

*Simon Higgins*

*Naser Sedghi*

*Munira Raja*

*Giles Lloyd*

*Kevin Molloy*

*Rafaella Di Lucrezia*

**Liverpool University**: *Carbon Based Electronics*

*Large area electronics*

- *flat panel/roll-up displays*
- *electronic newspapers*
- *medical imaging*
- *electronic bar codes (rf tags)*
- *security documents*

*e.g building access*

*luggage tracking labels*

- *active signage/advertising hoardings*

*etc*

***CBE consortium***:

*Cambridge: Chemistry*

*Physics*

*Engineering*

*Bristol: Physics*

*Heriot Watt: Physics*

*Imperial: Physics*

*KCL: Physics*

*Liverpool: Chemistry*

*Electronics*

*Oxford: Chemistry*

*Surrey: Electronics*

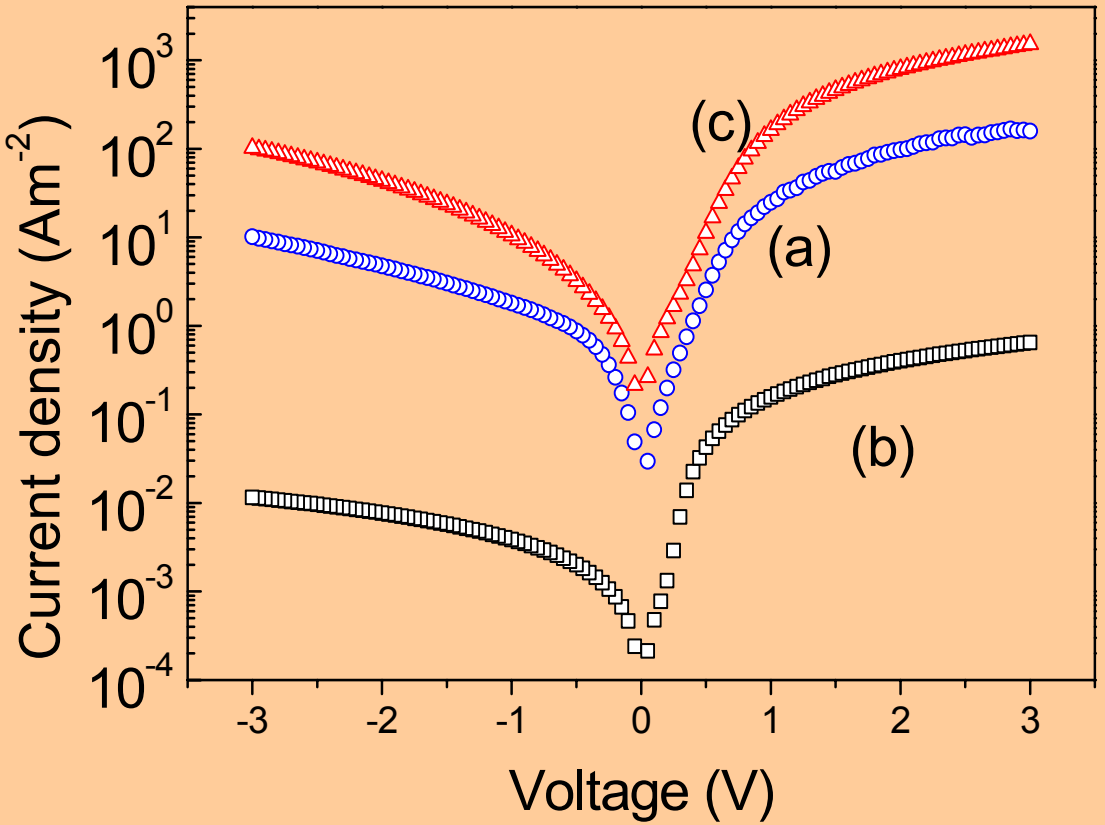
*Sussex: Chemistry*

*UCL: Electronics*

*Physics*

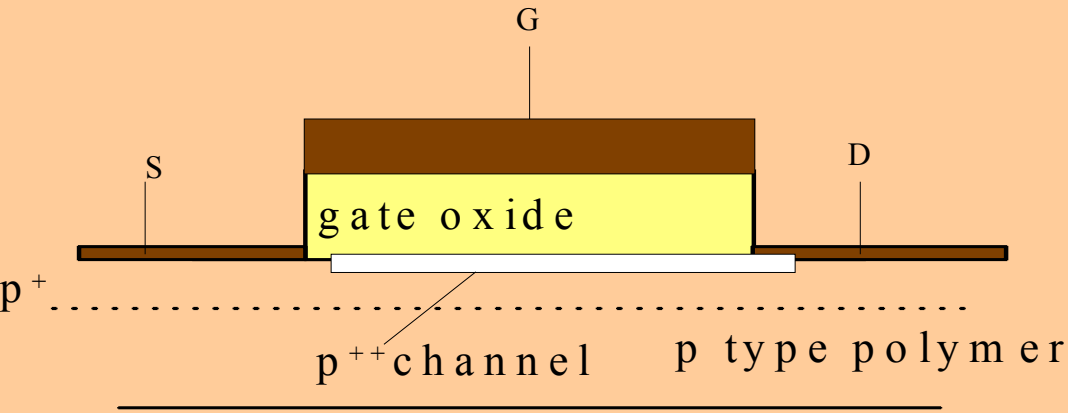
## *European Organisations*

- *Philips*
- *Siemens*
- *Infineon*
- *ST*
- *CDT*
- *Plasticlogic*
- *Motorola*
- *IMEC*
- *Cambridge Univ.*
- *Imperial College*
- *Durham*
- *Bangor*
- *Avecia*
- *Merck*
- *Bayer*
- *Cybernetix*
- *Sheffield*
- *Manchester*
- *Fraunhofer(Berlin)*
- *Fraunhofer (Munich)*
- *CNRS*
- *University of Paris*
- *>30 other organisations*



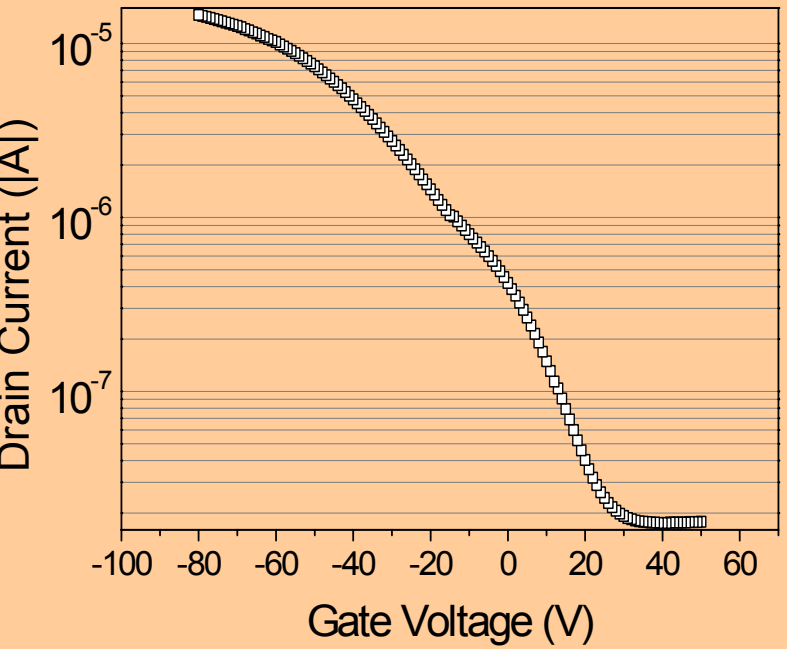

- *as synthesised-(a)*
- *fractionated-(b)*
- *doped-(c)*

*Effect of dopant on Schottky diodes*



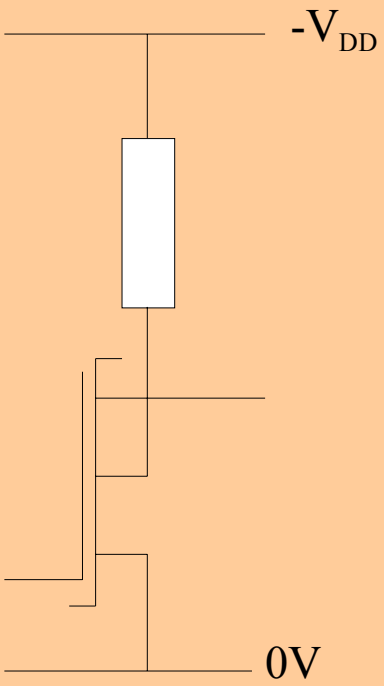

- *source reverse biased*
- *drain forward*
- *polymer gives back bias*

# *Schottky thin film transistor*

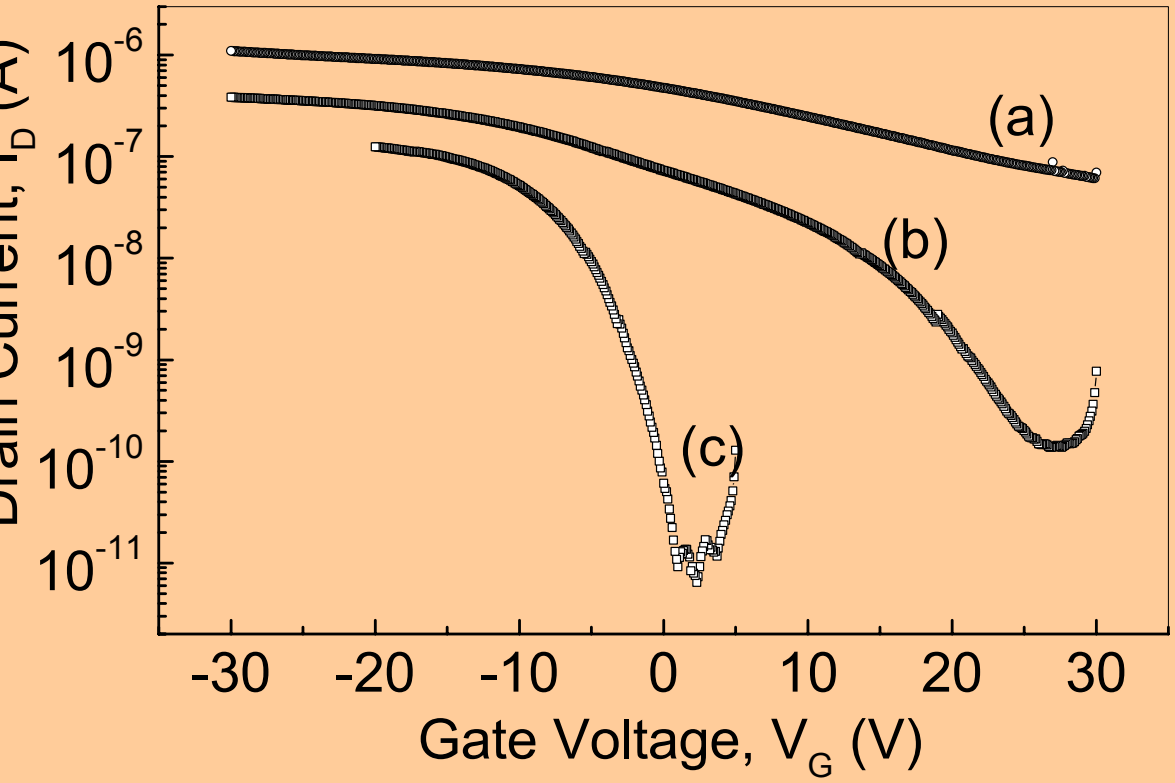



- *depletion device*
- *stable off-current*
- *needs thin high K dielectric*

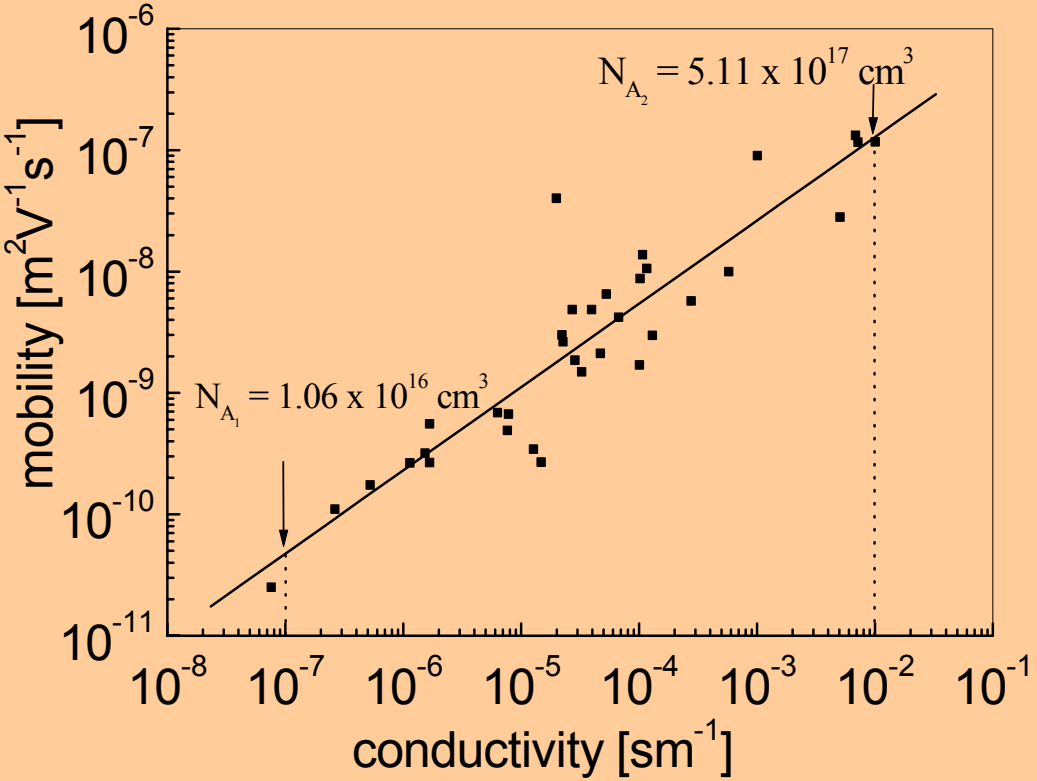
*Schottky Thin Film Transistor*




- *active back bias*
- *new load structure*




- *0.5 micronfilm (a)*
- *0.1 micron film (b)*
- *1nm film- VT=-1.2V (c)*




- *mobility very low*
- *strong dopant dependence*
- *channel mobility= 100x bulk mobility*

$$v/E = \mu,$$

*where v is the velocity of the carriers, E is the field down the channel*

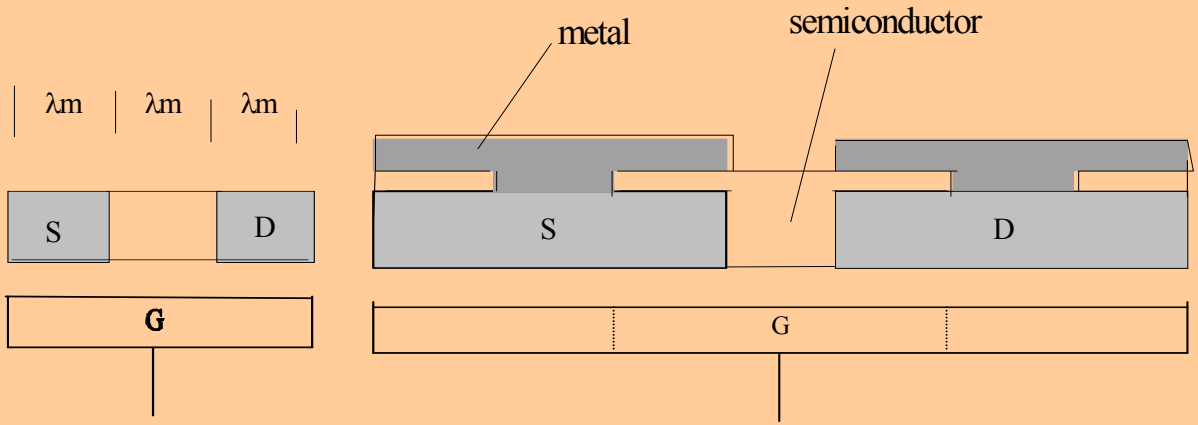
$$(L/\tau)(L/V) = \mu, \qquad (2)$$

*where* $\tau$ *= transit time for carriers down the channel,*
*V is the drain-source voltage.*

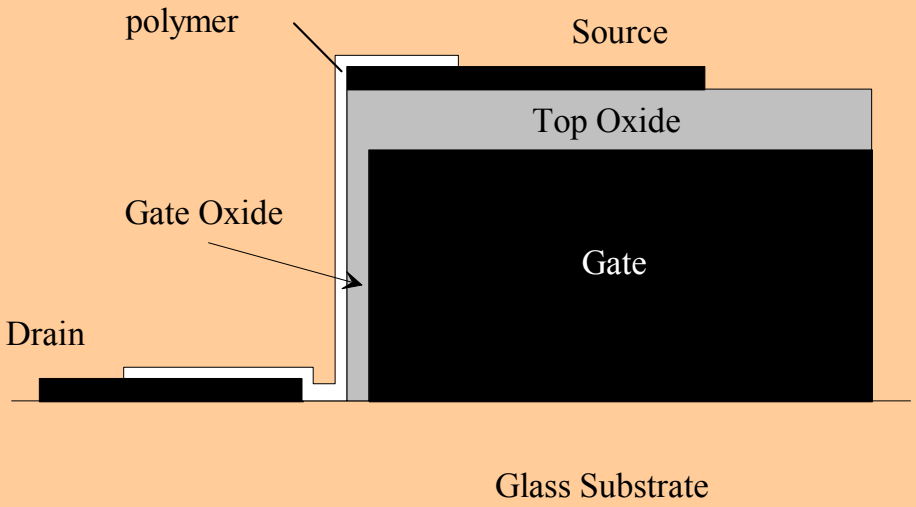
*if switching speed* $S \propto \tau^{-1}$ *then* $S \propto \mu V/L^2$ *from (2)*

*and for constant applied drain voltage*

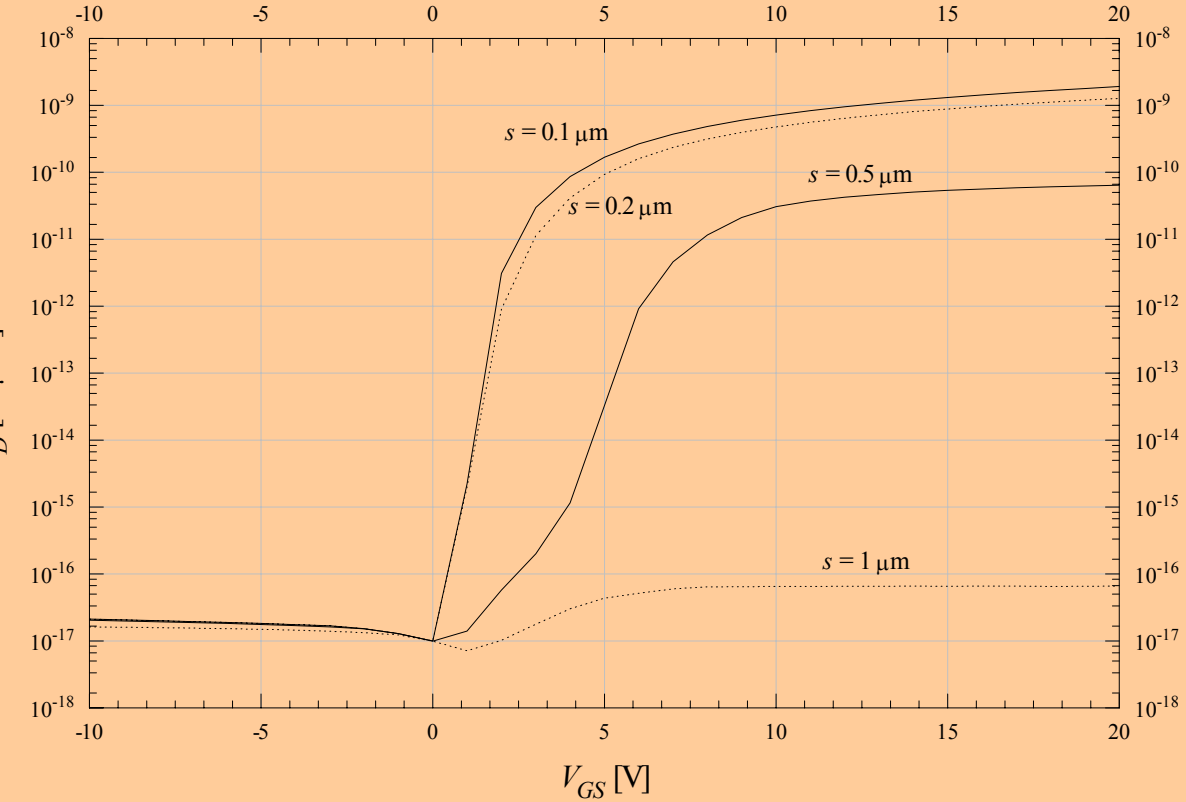
$$\underline{S \propto \mu/L^2.}$$



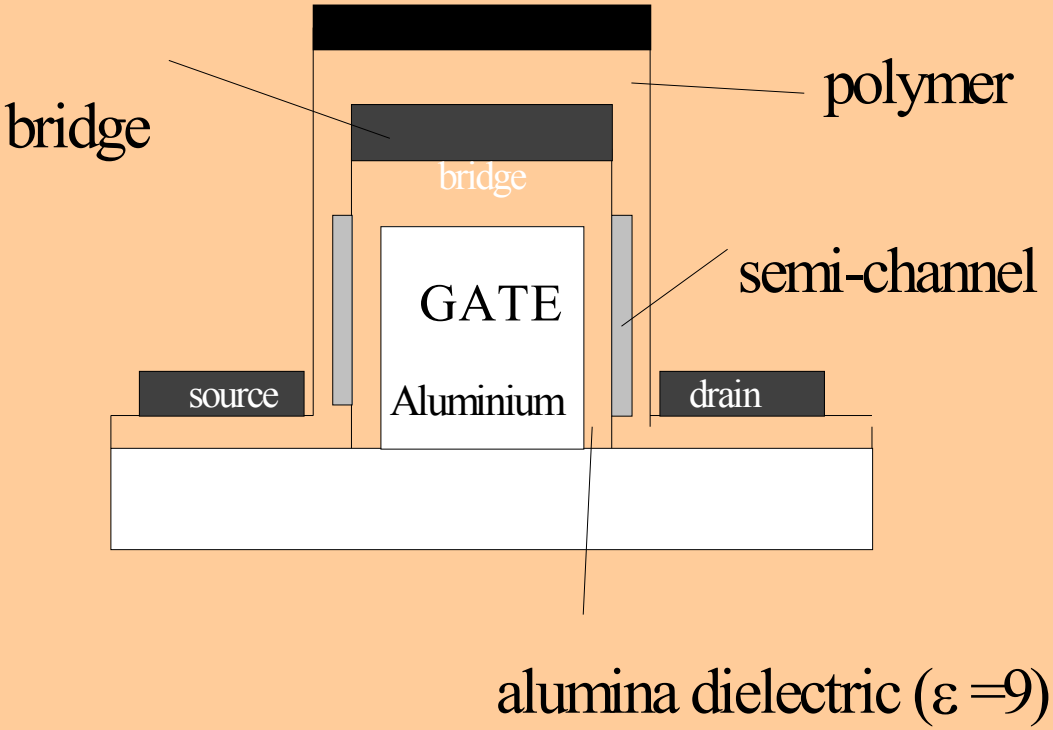

$$\frac{dQ}{dt} \propto \frac{\mu C_0 W / 10\lambda_m}{10 C_0 W \lambda_m} = \frac{\mu}{100\lambda_m{}^2}$$




*Idealised vertical channel transistor*




*Effect of source gap on transfer characteristic*




*Polymer vertical channel transistor: best so far*

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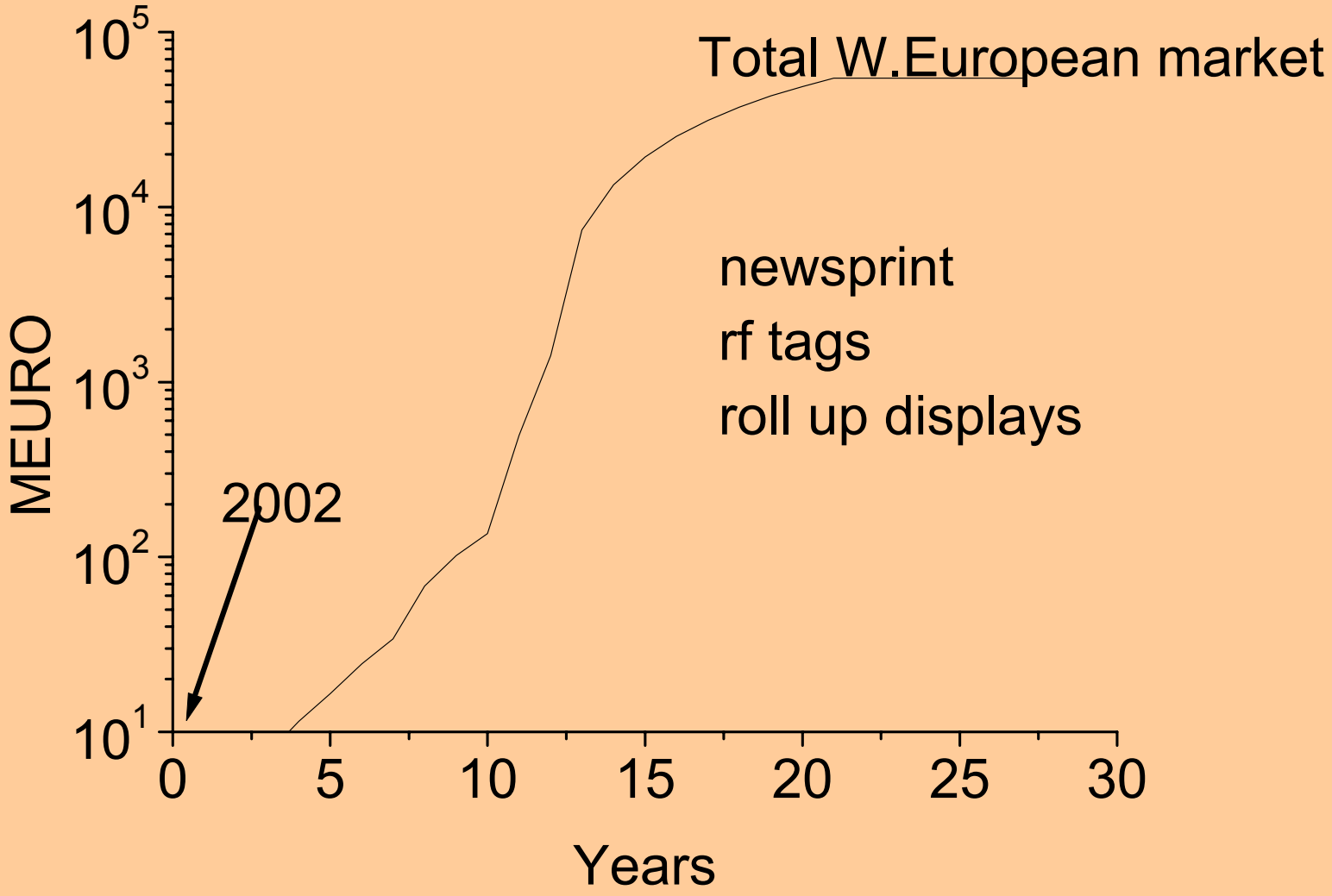


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***Conclusions***

- ***potentially huge market***
- ***radically new device and circuit concepts***
- ***not a competitor to silicon (yet)***
- ***disruptive to conventional print industries***
- ***exciting new physics and engineering***
- ***UK  in a leading position***