

TNO high-tech systems
Brussels, nov 2010

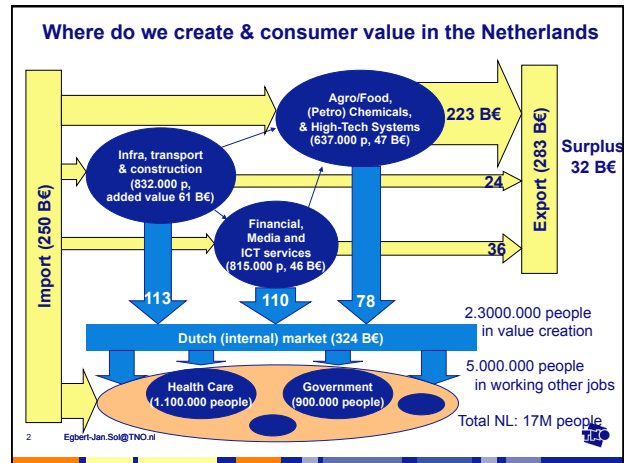


Dr Egbert-Jan Sol
TNO High-Tech Systems & Materials

TNO | Kennis voor zaken



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We ♥ factories

- Prof Westkamper: 13 april 2010 Valencia
 - "Lost factories never come back"
- Why factories back?
 - A factory is not a smoking chimney as on the road sign, but
 - A **factory** is where a society **concentrated** its **value creation**
 - Social & political attention is on consumption, i.e. cost creators
 - But how much attention is spent on **value creation**
 - No factories, no value creation, no welfare
- **Create value with less materials and less energy in a knowledge economy with innovations**



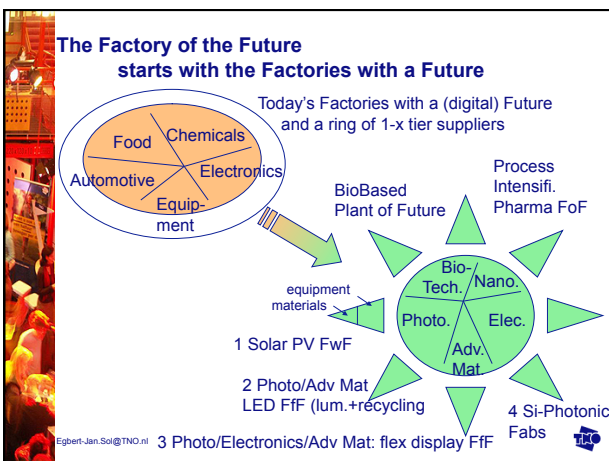

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The Factory of the Future

Avoid losing factories by improving them: factory with a (digital) future
And create new factories for new products: factories of the future

- **Factories With a Future – the high-performance, digital factory**
 - **Down-town production: onsite configuration, customized**
sustainable consumption, sustainable mobility in mega cities, minimal transport
 - **Green factory: low to zero emission, close loops (C2C)**
sustainable production, energy & material saving/recycling
 - **Next Gen IT for production: RFID, Robotics, Aging society**
- **Factories For the Future – volume production and resource lacking, knowledge rich Europe**
 - **Key Enabling Technologies:** photonics, nanoelectronics, nanotechnologies, biotechnologies, advanced materials
 - We need **Advanced Manufacturing Systems** to creating economical (at macro scale) value by adding material at nano-micro-atomic scale
 - Semicon fabs (chips), Photonics fabs (SSL (O)LED, Solar PV), Pharma, ...)

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Effect on recourses

Element	Consumption by 250 Mw/y plant [ton / year]	2007 Production [tons]	% by 1 plant of '07 production
Molybdenum	14	205.000	0,007%
Copper	19	1.540.000	0,001%
Indium	26	563	4,76%
Gallium	5	80	6,69%

Limiting factor: Production-capacity

- Gross input for fab
- No recycling or re-use taken into account

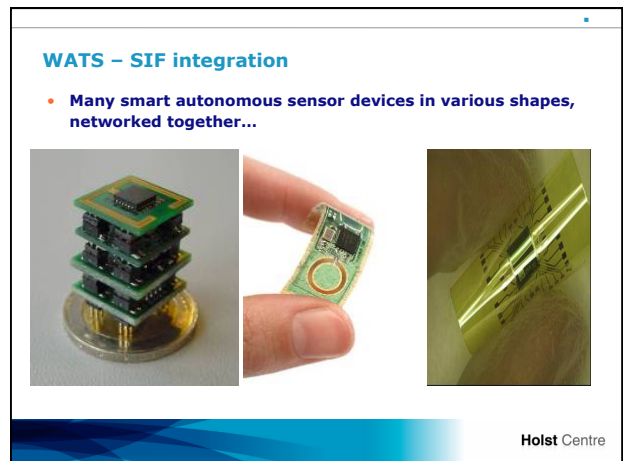
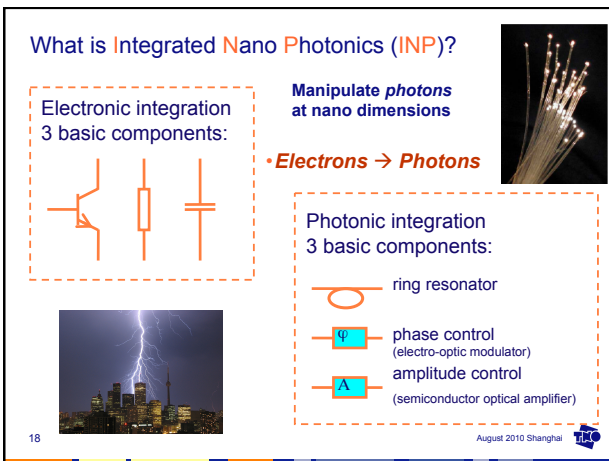
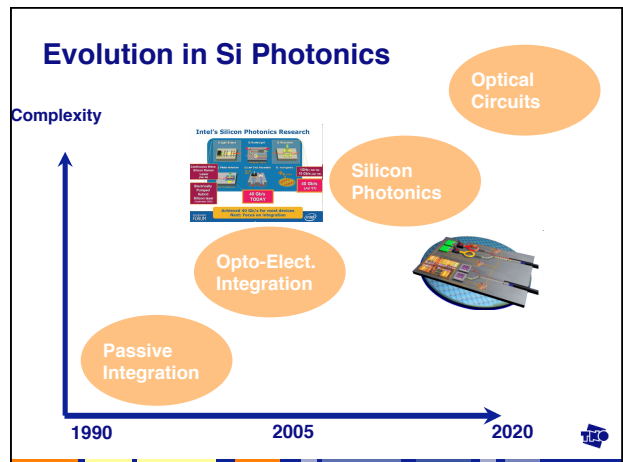
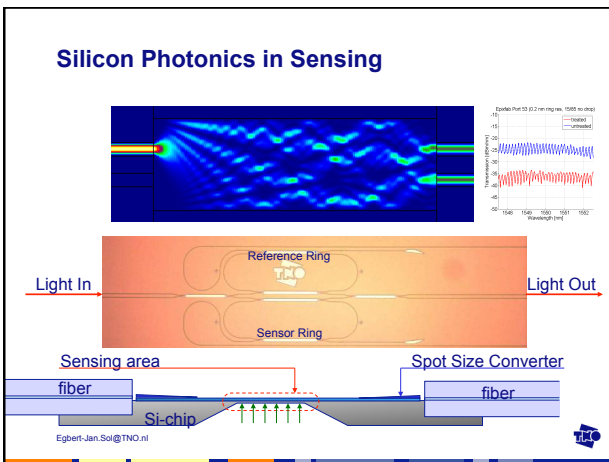
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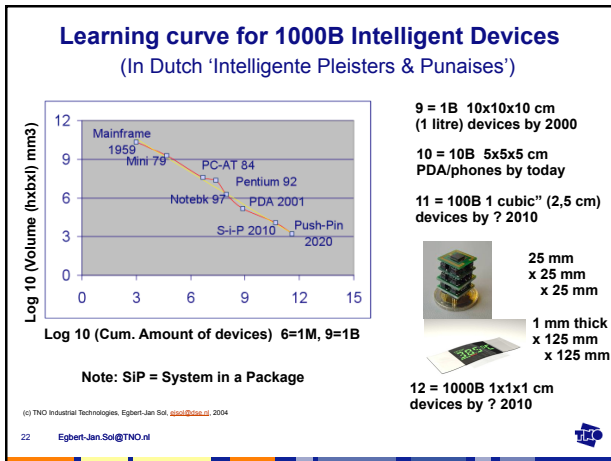


Material resources in SSL LED

- LED indium-gallium-nitride (IGN): ca. 25 nm IGN in 40 μm layer GaN
- Phosfor coating is 50 μm layer with YAG (Yttrium Aluminium) in grains of 1 μm of which 10 % of coating is mineraal: 1,75 mg/mm²
- LED-lamp of 40 W (5 die of 1 mm²):
 - 1 mg Gallium
 - 0,5 μg Indium
 - 60 μg Yttrium
- Europe replaces 2 Billion of these lamps: (
 - Gallium: 2030 kg (2,5 % of 80 ton year production in 2007)
 - Indium: 0,94 kg (2007 year production 563 ton)
 - Yttrium: 125 kg
- China's 2015 plan 50 miljard LED-lamps for 10 new cities with 1 M people.
 - Gallium: 50,75 ton (63,5 % of 2007 year production)
 - Indium: 23,5 kg
 - Yttrium: 3,125 ton

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The Grand Challenges & Value creation in Europe

energy and material savings, healthcare and aging society, low hydrocarbon economy, sustainable mobility, sustainable consumption & productions and JOBS, JOBS, JOBS,...

- Solar PV: +++
Knowledge intensive, sustainable energy, local factories in Europe Q-cells 250MW/year, in China new fab at 1GW/year (cheap credit, however buying Western European build equipment)
- LED: +
sustainable energy, by make it intelligent to shut off half the time Chinese target: 1 miljoen news jobs and 30-50B \$ turnover in 2015
- Intelligent LED & recyclability: +++
new lamp designs, recycling standards, etc., European leadership in recycling standards, European SBIR request intell. LED
- Si Photonics: ++
Data com strengths, sensor complexity, low volume, high value Using the SBIR to bridge the gap between initial (before design-in) and normal volume Si Photonichips

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