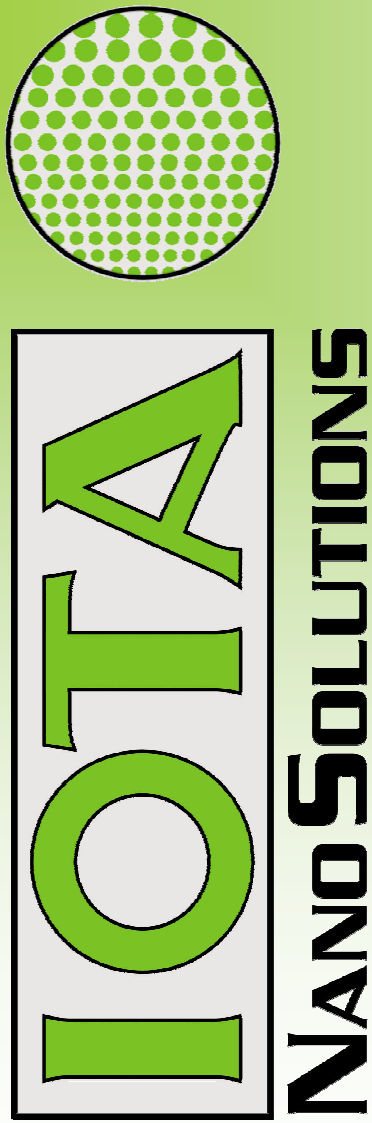


Commercializing Nanotechnology - Practical Observations from "Start Up" on.

Andrew Elphick
CEO Iota

Jan 7th 2008
Pune,

Contents:

- Context
- Iota NanoSolutions Limited – A Start Up Case Study.
- Examples of the Iota technology and it's application
- Observations from "Start Up" on….

Size in perspective

50-80µm

7µm

Influenza Virus
150nm

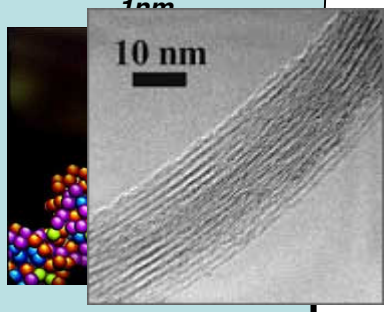
1m 10^{-1}m 10^{-2}m 10^{-3}m 10^{-4}m 10^{-5}m 10^{-6}m 10^{-7}m 10^{-8}m 10^{-9}m 10^{-10}m

10^{-2}m = 1cm

10^{-3}m = 1mm

10^{-6}m = 1µm

10^{-7}m = 100nm

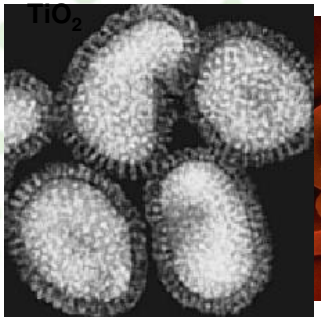


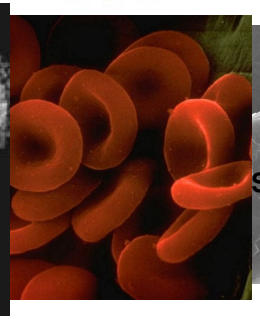
100nm 10^{-7}m

50nm

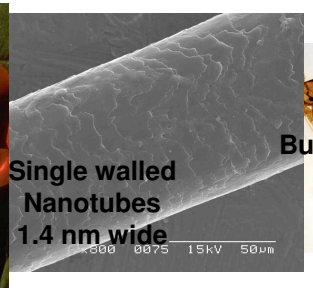
1nm 10^{-9}m

10^{-10}m

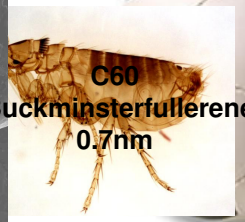




DNA
2nm wide



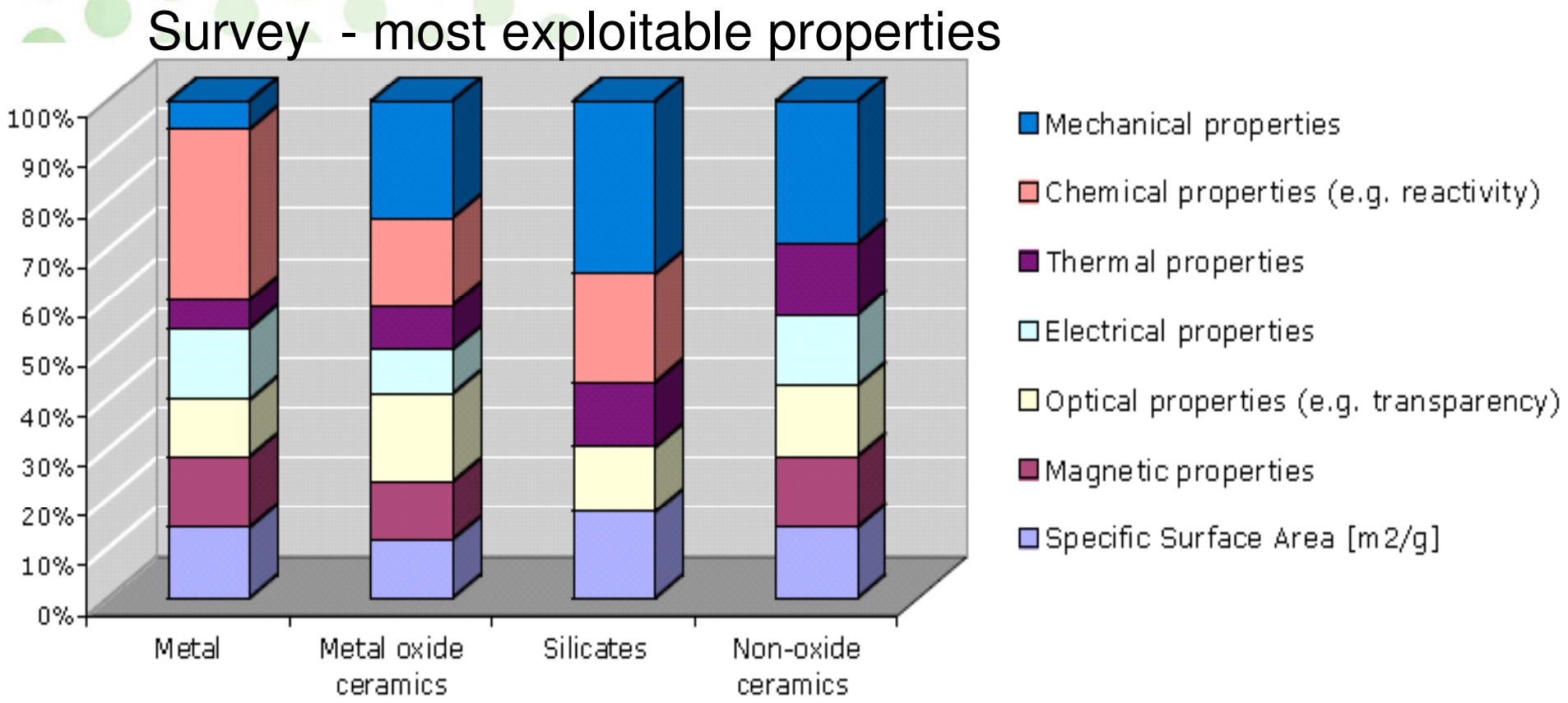
Single walled
Nanotubes
1.4 nm wide



C60
Buckminsterfullerene
0.7nm

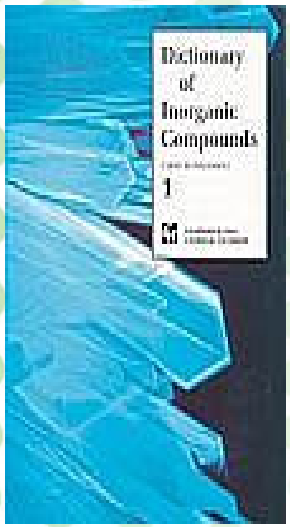
Nanotechnology ≈ Nanoparticles
(and mainly inorganic particles at that)

- *EU NanoTechnology Roadmap - 2005*

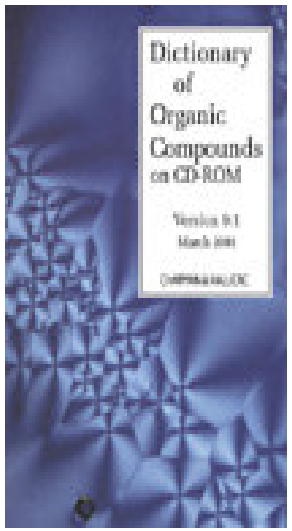


What about Organic Materials?

- Organic vs Inorganic Chemistry?
  - Thursday Jan 3rd 09.54 EST 2008
    - Count 33, 524,612 organic and inorganic substances



44,000 common compounds listed

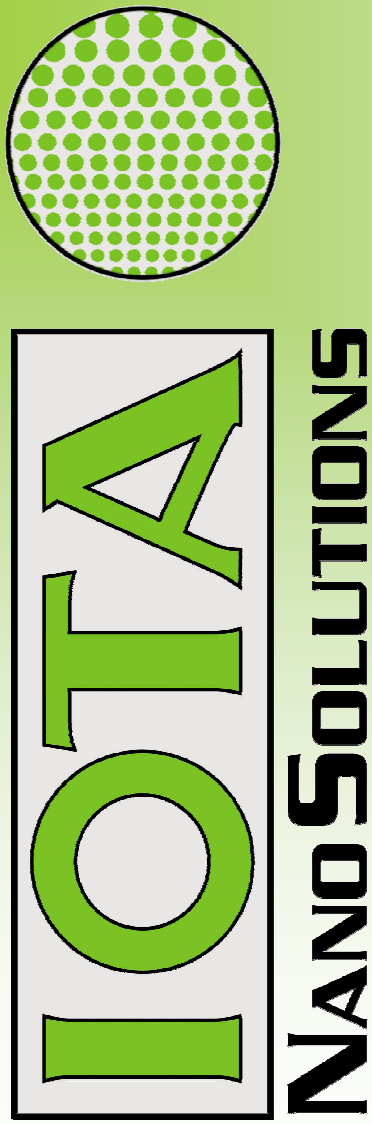


255,000 common compounds listed

Chapman & Hall/CRC Press

Iota NanoSolutions Limited

- Many organic materials are hydrophobic
  - Formulation issues
    - Most common formulation solvent is water
    - Many compounds are “overdosed” to ensure loadings
  - Activity issues
    - Pharma sector
      - Approx. 40% of new chemical entities (NCE’s) discovered have little or no water solubility
    - Since 1995 (approved drugs)
      - >90% have poor solubility, poor permeability, or both
      - Approx. 16% have performance issues due to poor solubility and low bioavailability
- Many existing actives (and potential new actives) are rejected due to solubility – not efficacy
- Example commercial materials
  - Fipronil (insecticide) – Solubility 1.9mg/l, Application 50/120 g/ha, 2003 Sales $240m
  - Trifloxystrobin (fungicide) – Solubility 610µg/l, Application 60/180 g/ha, 2003 Sales $225m



Iota NanoSolutions "Enabling the use of Hydrophobic actives through Nanotechnology" A Case Study

Technology origins and birth of Iota (2002 - 2004)

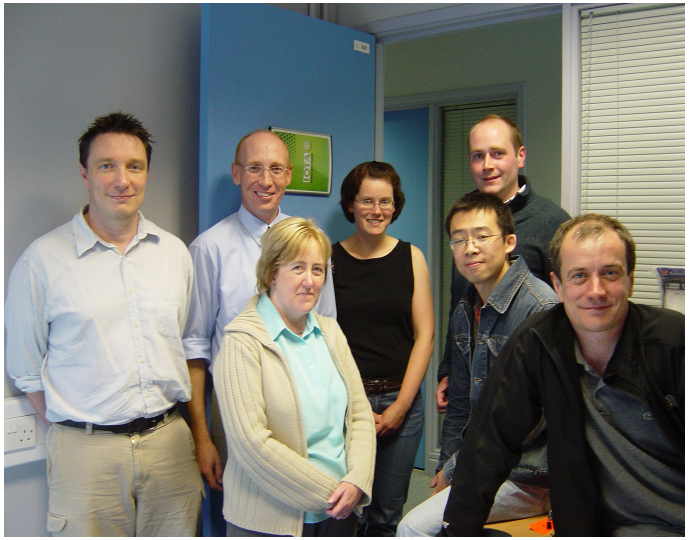
- Initial work at Liverpool
  - Prof Andy Cooper and Dr Haifei Zhang
  - EPSRC funded project
  - 2 patents filed

- Unilever Corporate Research project
  - Internal work at Port Sunlight
  - Focus of new chemical methods

- Open discussion about Liverpool technology
- Incorporation into Unilever project
- Corp. Funding of Postdoctoral work (HZ)
  - Two further postdocs
- Patent negotiations led to Unilever purchase of technology
- To date 14 patents have been filed (further patents planned)

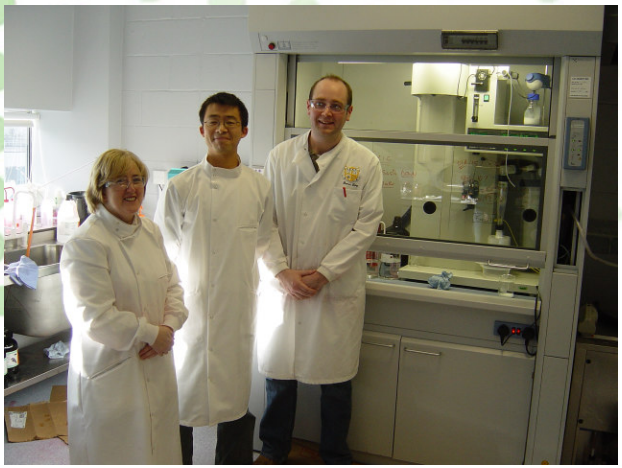
2005 - date

- Unilever Corporate Research support further development but
  - internal business traction lacking
  - breadth of opportunity too wide for Foods and H&PC businesses.
- Iota Born
  - Driven by Steve Rannard
  - Funded by Unilever Ventures
  - Company registered June 2005
  - 4 Founders
    - Dave Duncalf (U), Alison Foster (U),
    - Steve Rannard (U), Andy Cooper (UOL)
  - Based in MerseyBio Incubator
  - UOL have an equity share
  - Team of 11



Facilities and Resource

- Facilities and resource



Iota NanoSolutions Limited

"Enabling the use of insoluble actives through nanotechnology"

- **Iota NanoSolutions Technology**
  - A set of core manufacturing/process technologies
  - Focussed on addressing the issues of using insoluble organic materials in aqueous environments
  - Application of our core technologies to "problem materials"
  - Formation of nanodispersions of organics rather than solutions
  - Active/Problem from Customer – Process and Nano-material from Iota - Applications Together
- Advantages
  - No chemical changes to the material
  - Rapid formation of a usable "solution"
    - Actually a nanodispersion – particles <350nm
  - Safe and scaleable technology
  - Avoids the use of solvents or high surfactant loadings

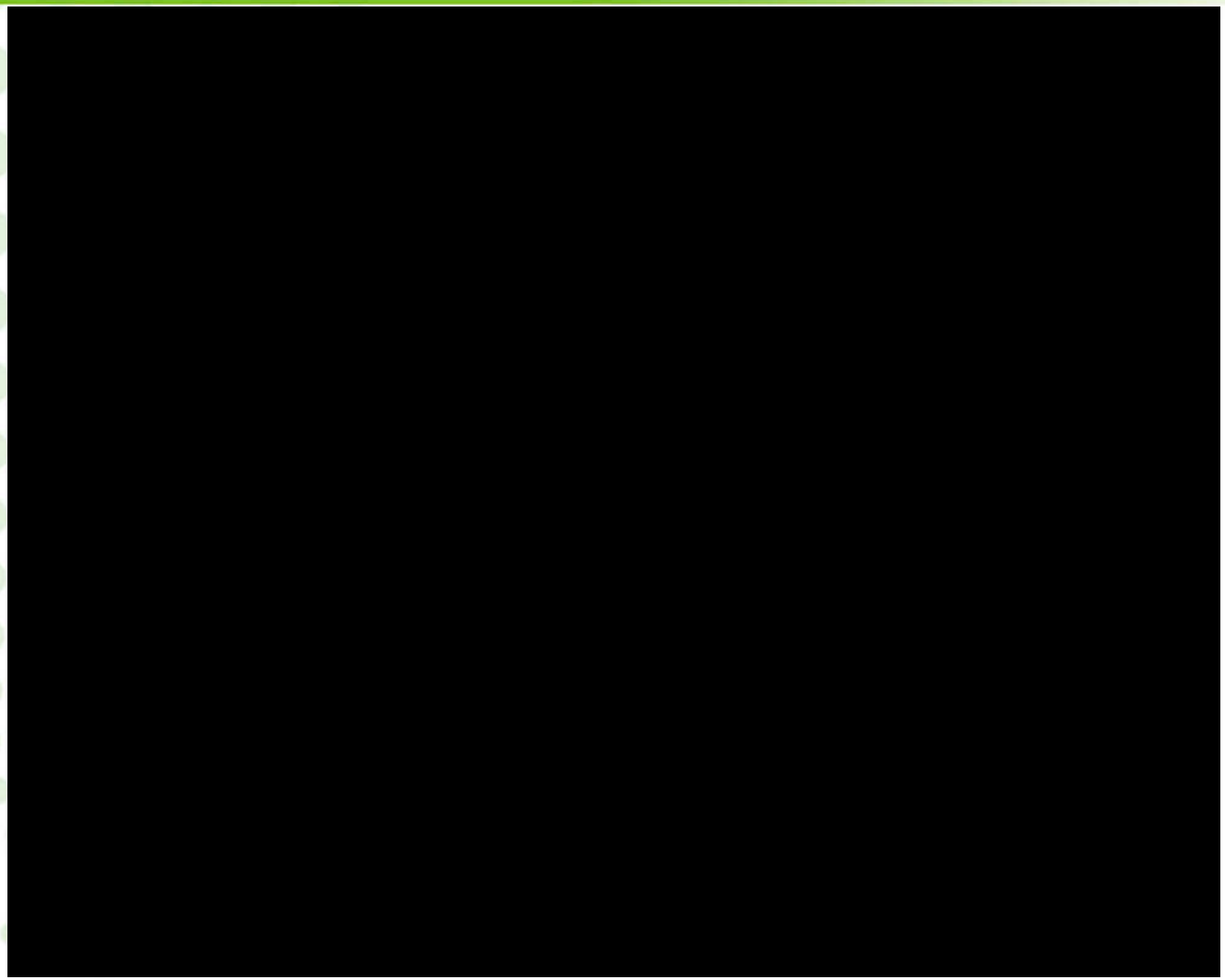
Iota NanoSolutions

- Hydrophobic material dispersed into water

Unprocessed dye

Processed dye

Video Explanation



Generic technology

- Iota creates stable powders which form nano-dispersions when added to a liquid.
- Iota approaches seem to be applicable generally to organic materials

- Broad range of market sectors available
  - Pharmaceuticals, Agrochemicals, Nutraceuticals, Cosmetics, Fine Chemicals, Biocides, Inks and Coatings, Foods, Flavours, Home and Personal Care

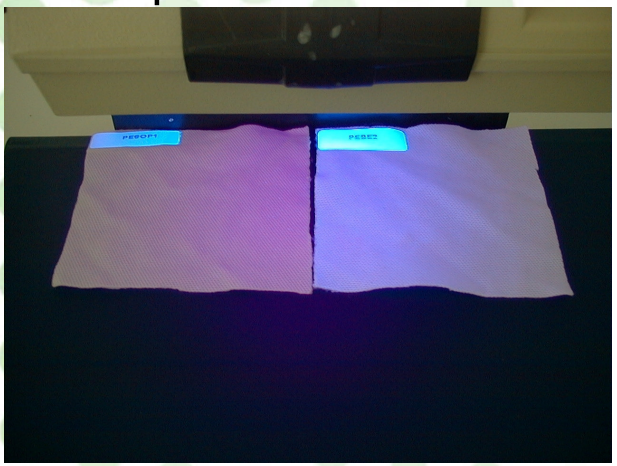
- Example materials (<210 materials now processed)
  - Vitamins, sunscreens, antimicrobials, antifungals, OTC and prescription pharmaceuticals, fungicides, pesticides, preservatives, flavours, dyes, fluorescers, catalysts etc etc etc…

Application Case Studies

1. Fluorescer (deposition)
2. Antimicrobial (enhanced activity)
3. ‘Soluble’ Aspirin (clear – highly available nano-dispersion)

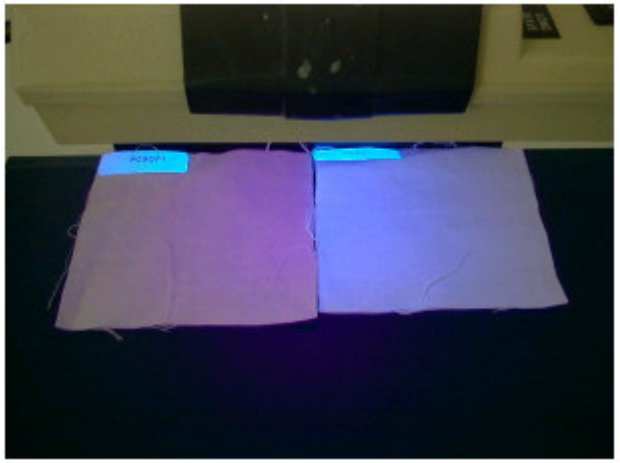
Case Study 1. Fluorescer deposition

- Simulated Laundry washing procedures (with rinsing)
  - Iota processed fluorescer vs ground powder (equilibrated in surfactant)



Polyester

Polycotton

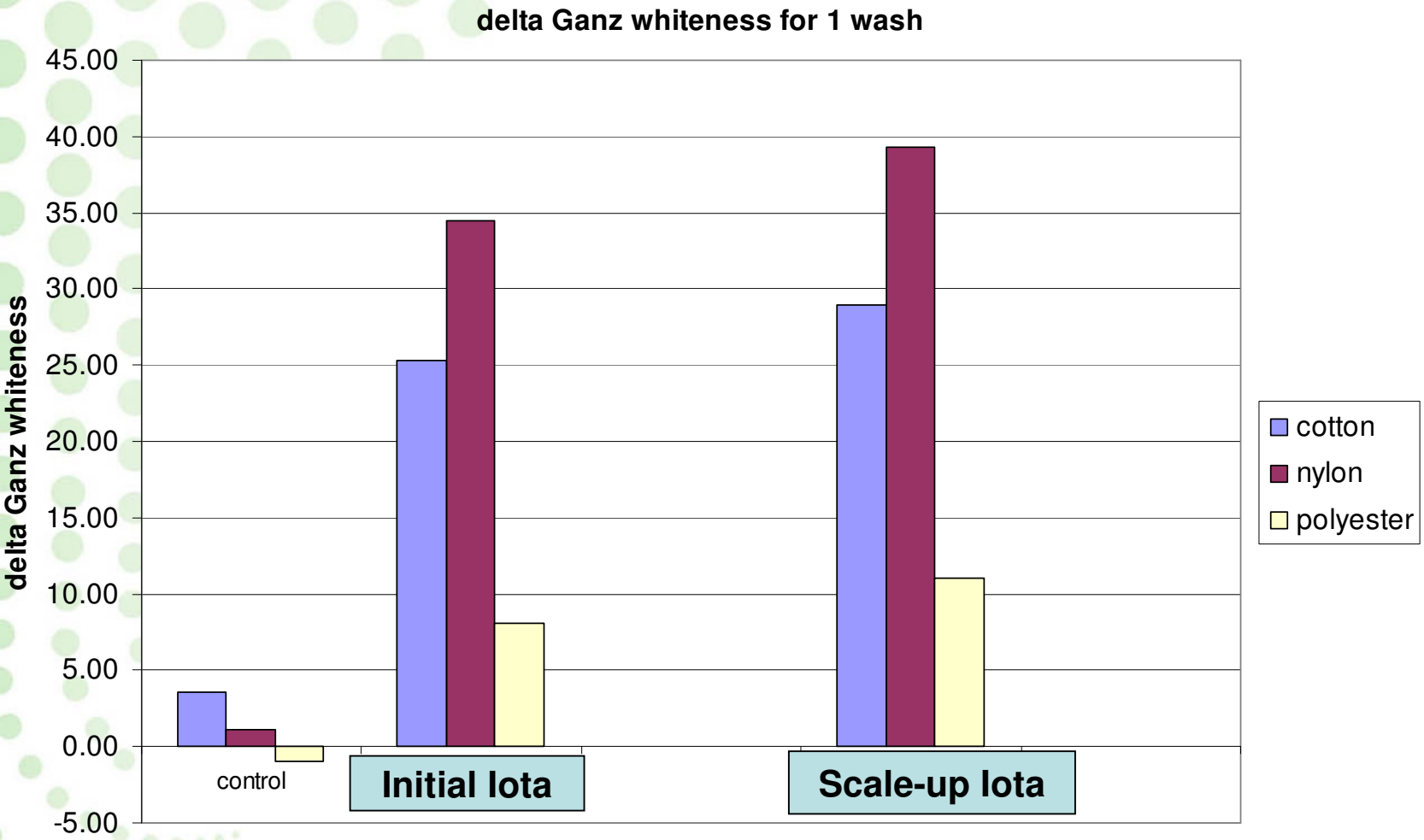


Cotton

Nylon

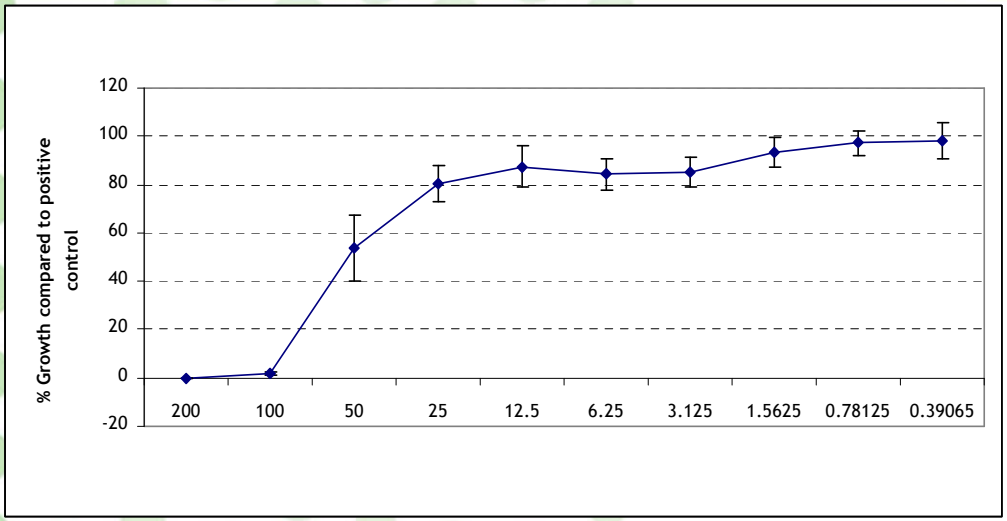
Whiteness measurements

- Enhancement of performance

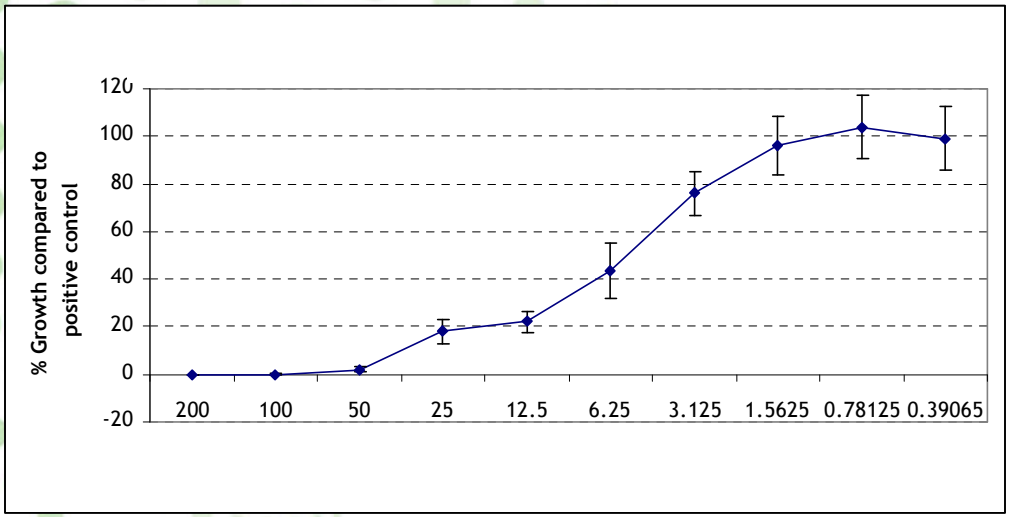


Average of 10 repeats

Case Study 2. Hydrophobic antimicrobials - MIC



Aq Alcohol
MIC = ~50 ppm



Aq Dispersion
MIC = ~6.25 ppm

Similar behaviour demonstrated:

a) Antifungals
b) Yeast control
c) Antiparasitics

Case Study 3. 'Soluble' Aspirin

- Many current formulations produce cloudy dispersions that may contain 'lumps' of excipient/active
- Aspirin particles, when not dissolved fully can cause gastric irritation
- Iota formulation produces clear dispersion within 2 minutes.
- Small particles dissolve

Comparison Between Samples

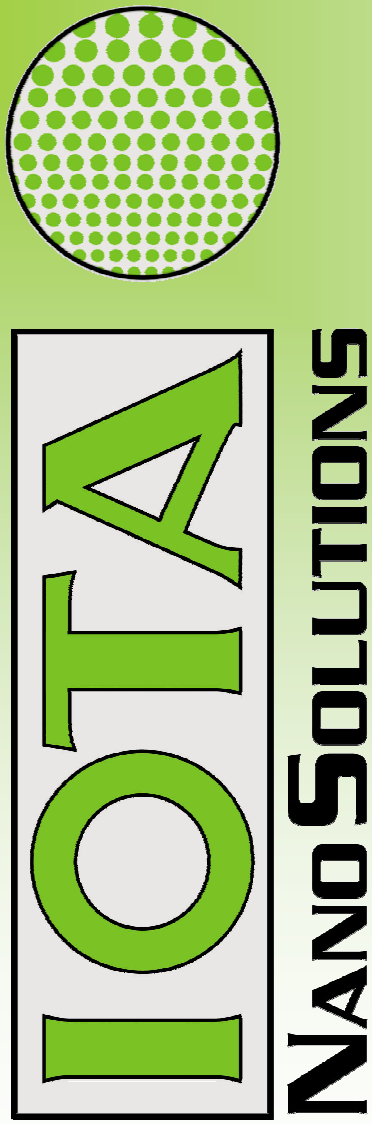
Commercial samples considered

Aspro Clear, Dispersible Aspirin (Asda), Anadin (+ paracetamol), Disprin, Alka-Seltzer

Test		**Commercial Samples**	**Iota Sample**
Dissolution (%)	**1 min**	23 – 69	95 - 100
	5 min	22 – 93	
Appearance of Dispersion		Cloudy, not fully dissolved	Clear
Particle Size (nm)		100 - 1170	127 - 185
Loading in powder/tablet (wt%)		11 – 63	75 - 95

Summary

- Iota NanoSolutions
  - An active nanotechnology spin-out from Unilever
    - Born out of original work at the University of Liverpool
  - Focussed on forming nanodispersions of organic materials in water
  - Value creation from enhancing the ease of formulation, increasing activity and novel product formation
  - Working with Partners for 90% of what we do.
  - Joint Development and Licensing for specific active/application combinations
  - In 2008 we will be 45% Bio/Pharma/Diagnostics, 15%Agro/Biocides, 15% Food/Nutraceuticals, 10%Inks/Coatings/Polymers and 15% Home and Pers. Care.



Commercializing Nanotechnology - Practical Observations from "Start Up"

Practical Observations from "Start Up" on.

- Personal Observations
- "Start up" centric but rooted in 20 years within multi-nationals
- A failed Scientist who loves taking Science based developments to the Market with Scientists
- Time/Development dependent
- Hopefully simple and mostly "common sense"

New Audiences – Don't let your best new idea be ignored

- Start thinking about a new audience from day one.
- To date being "published" in a learned international journal may have been the height of success but from now on you have to start thinking differently.
- You have 3 New Potential Audiences
  - Customers
  - Investors
  - Employees
- Different Audiences "speak" different languages.
- But whether it's £, $, Euro or INR – This will be the closest thing to a common Language.

New Audiences (Continued)

- Translate complex scientific developments into simple concepts which the non-scientist can understand.
- Forget for a moment how clever your invention is and how “ground breaking” the science that supports it is- start to think
  - what will it do, make better, make safer, make cheaper, make fast, make for the first time….(be careful with this last one as it is often the most exciting but most difficult to sell)
- Retain your good scientific “proof” but start thinking “benefits”

New Audiences (Continued)

- Application Testing
  - The science that proves that you new invention really does what you claim it does.
  - Applications are where the value sits!
    - Can you do it yourself
    - Which Standard / technique?
    - Results from a credible source?
- Assume ignorance and scepticism

Building a team

- Broaden your organisation's skills, experience and network with every hire.
- Be brutally honest about your skills – If you have never engaged with the commercial world, don't like it and don't intend to learn – get in some help (and give them the space to help you)
- Get in over qualified admin support
  - Understanding your business not typing speed
- If you want to spend someone else's money get help from an accountant/Book keeper
- Everyone as a business developer!

Markets and Customers .

- Start thinking about your markets early
- Who would your customers be?
  - Is direct access to your end market realistic or desirable and if not who could do this for you.
  - Cast your net wide (the market leader may have least to gain from a disruptive new technology)
  - If you want a framework try Porter's Five Force model
- Network yourself into multiple prospects at one time
  - Attrition rates are high and most accounts will be need sustained nurturing
- Persevere
  - The value and significance of every import product development was not realised at first.
  - Expect rejection and learn from it. In reality business development is an iterative process

Intellectual Property

- Love your Patent Agent – Build them into your team make sure they understand your strategy and how you can work together to build strength into the business
- Intellectual Property is likely to be your greatest asset and your greatest source of competitive advantage (be sure you control it!)
- Seek to understands Patents and the relative strengths and weakness (and interdependence) of material and application type patents (particularly when you start to work collaborative with customers / partners.)

Lawyers – More fees!

- Get access to a good commercial lawyer (with relevant experience if possible)
- You are in business now – you get what your negotiate but and well written contract will translate what you agree into what you actually get
- Get your company basic framework versions of these agreements and understand what they mean.
  - Material transfer agreement
  - Non-analysis agreement
  - Confidentiality agreement
  - Joint Development Agreements
- Understand the links between your Contracts and IP

Location Location Location

- The issue of business location may not feature in every case but where it does and if given the choice - follow the crowd - Clusters evolve for very good reasons.
- It's unlikely there will be a nano-hub round the corner so follow
  - Key skill needs
  - Service providers
  - Accessibility drivers (access to airports)
- Physics, Chemistry, Bio-Science, or Computer Science clusters may all work well.
- Your Markets are international – you need to be on a world stage

From "start up" on……

- Starting a Science based business from the "bottom up" and outside the supporting frame work of an existing Corporation is tough
- Selling something entirely new to a sceptical and ignorant world is tough
- But when you successfully complete your first

Customer Presentation

Product Sale

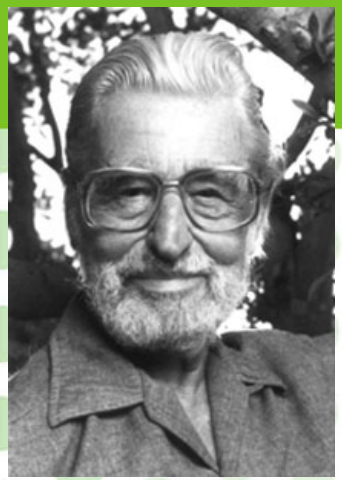
Funding Round

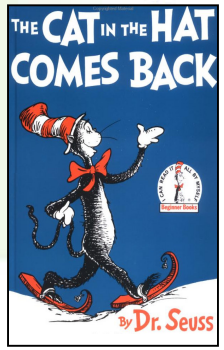
Cash positive month

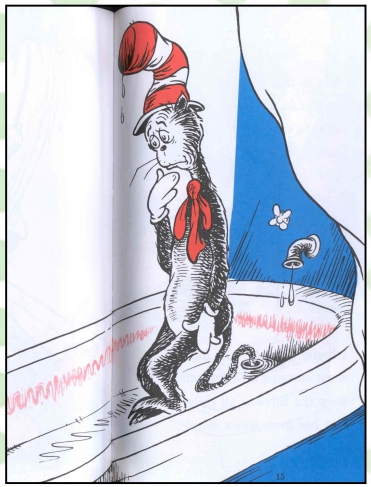
IPO

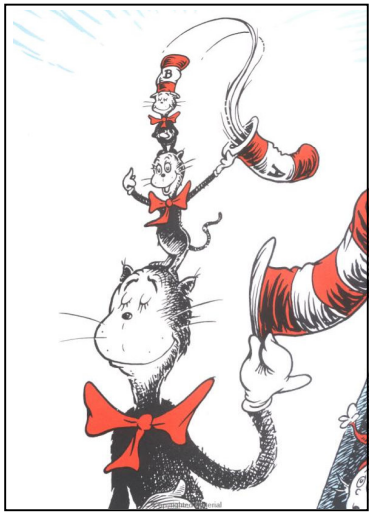
- You will have had the immense satisfaction of creating your own success!

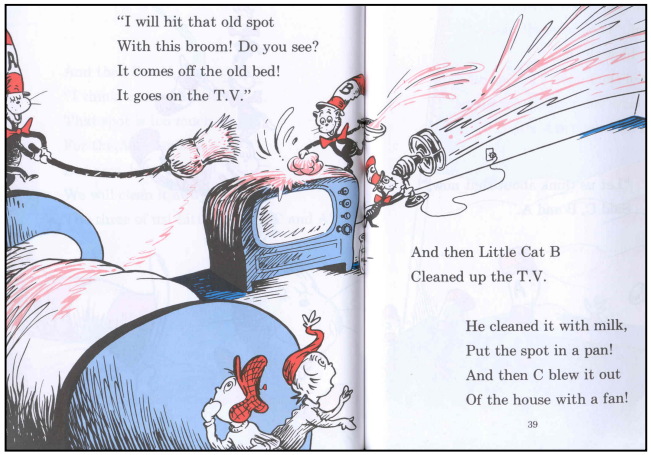
And Finally

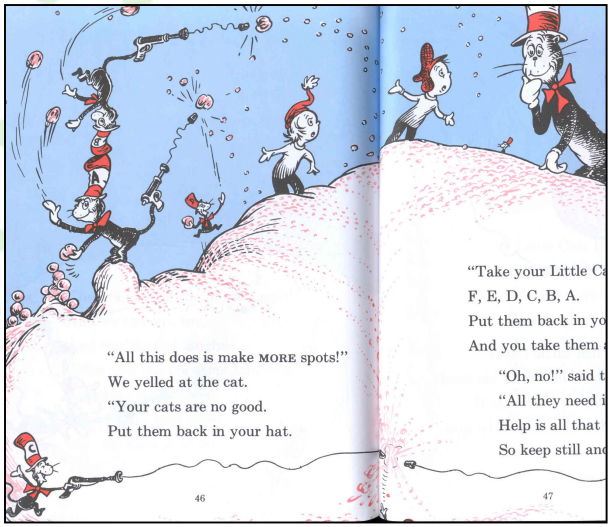


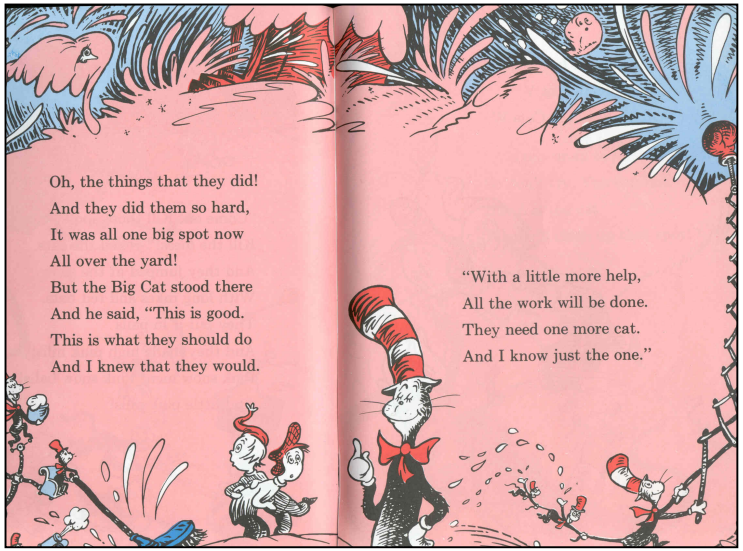

THE CAT IN THE HAT
COMES BACK
By Dr. Seuss

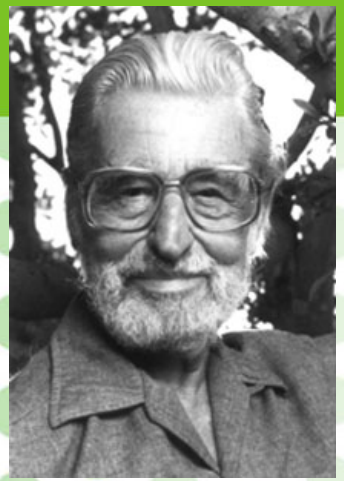


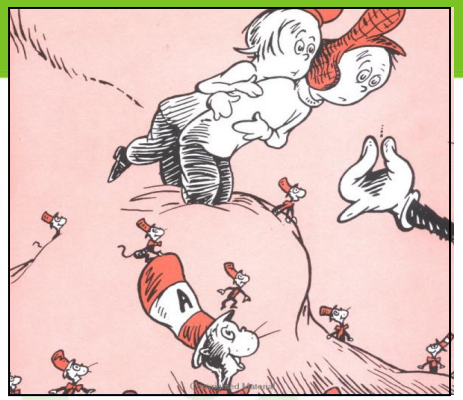


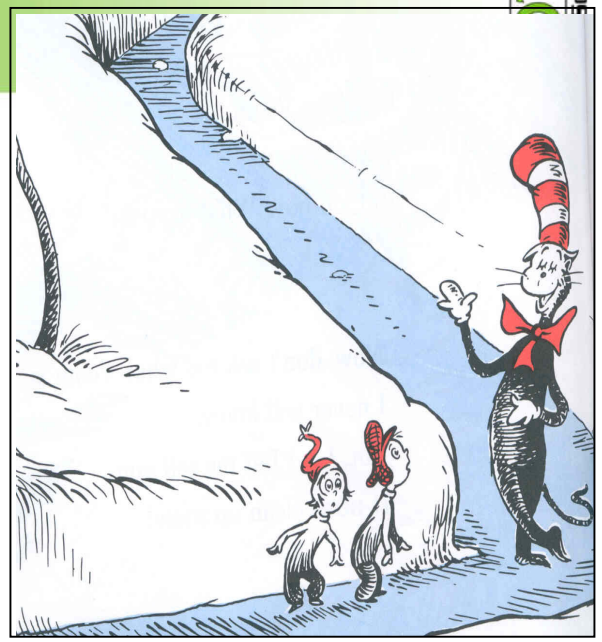

"I will hit that old spot
With this broom! Do you see?
It comes off the old bed!
It goes on the T.V."
And then Little Cat B
Cleaned up the T.V.
He cleaned it with milk,
Put the spot in a pan!
And then C blew it out
Of the house with a fan!
39

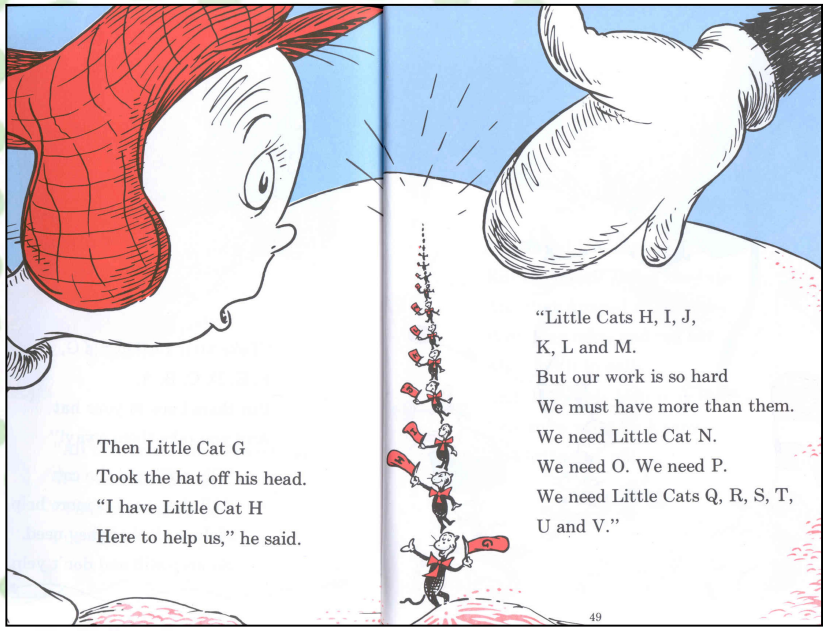

"All this does is make MORE spots!"
We yelled at the cat.
"Your cats are no good.
Put them back in your hat.
46
"Take your Little C
F, E, D, C, B, A.
Put them back in yo
And you take them
"Oh, no!" said t
"All they need i
Help is all that
So keep still an
47


Oh, the things that they did!
And they did them so hard,
It was all one big spot now
All over the yard!
But the Big Cat stood there
And he said, "This is good.
This is what they should do
And I knew that they would.
"With a little more help,
All the work will be done.
They need one more cat.
And I know just the one."



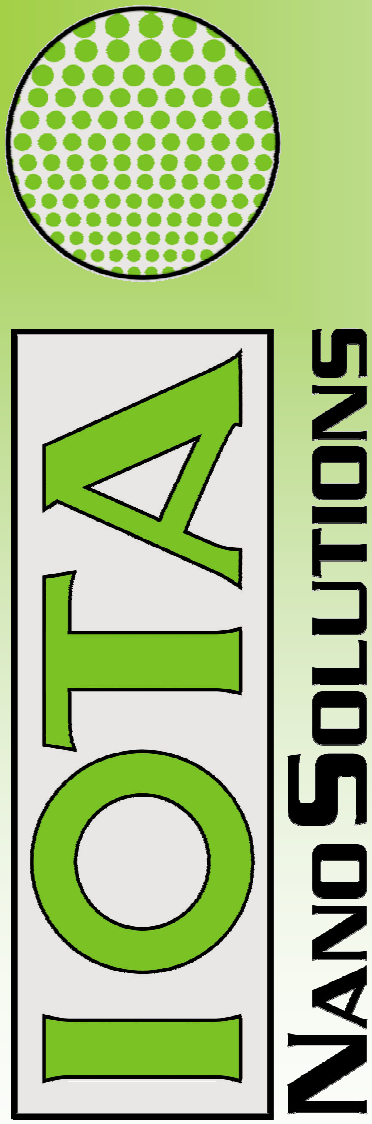






So how big is little Cat Z?

- Assuming the Cat in the Hat is 2 metres tall and each Little Cat is half the height of the previous one, Little Cat Z is 2^{-25} metres high, or about 25 nanometres!
- Voom is a nanotech solution!



Thank You