

# KIDS QD & PV WORKSHOP

9th Feb. 2018

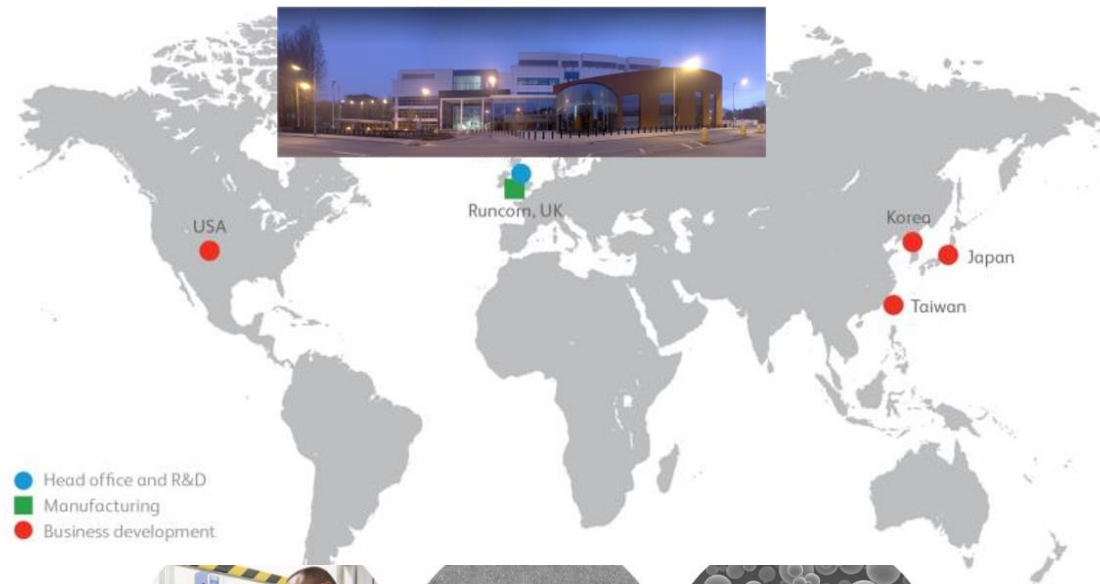


*The following presentation is being made only to, and is only directed at, persons to whom such presentation may lawfully be communicated (“relevant persons”). Any person who is not a relevant person should not act or rely on this presentation or any of its contents. This presentation does not constitute an offering of securities or otherwise constitute an invitation or inducement to any person to underwrite, subscribe for or otherwise acquire securities in Nanoco Group PLC or any of its subsidiaries (“Nanoco”).*

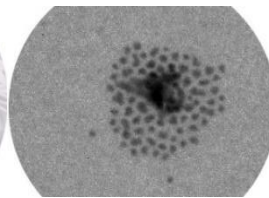
*It should be noted that past performance cannot be relied on as a guide to future performance. This presentation contains forward-looking statements with respect to Nanoco’s plans and objectives regarding its financial conditions, results of operations and businesses.*

# COMPANY OVERVIEW

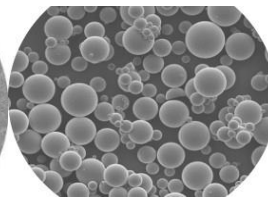
## Key Territories and Operations



Process



Materials



Surface chemistry



Display



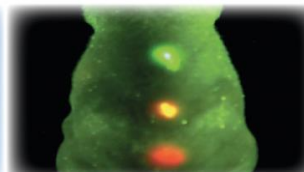
Lighting



Solar



Biomedical



- Pioneer and world leader in the development and production of cadmium-free quantum dots (CFQDs)
- Scalable "platform technology" with multiple markets and product applications
- Extensive patent portfolio, c.600 patents granted / pending
- Main focus to date is the display market; other markets now showing encouraging progress
- R&D in Manchester
- Manufacturing in Runcorn
- Listing on the London Stock Exchange "FTSE", Ticker: NANO.L

- The report from Oeko-Institute recommended a further 3 year extension, but after concern from Member States and environmental NGOs the EC decided to end their use in LED lighting and give the minimum period of 2 years only for use in displays
- Cadmium-based quantum dots in displays will be effectively banned from 31<sup>st</sup> October 2019, since the normal RoHS limit of 100ppm will apply once the exemption ends
- Nanoco expects that regulations in other key markets, including China, will fall in line with RoHS





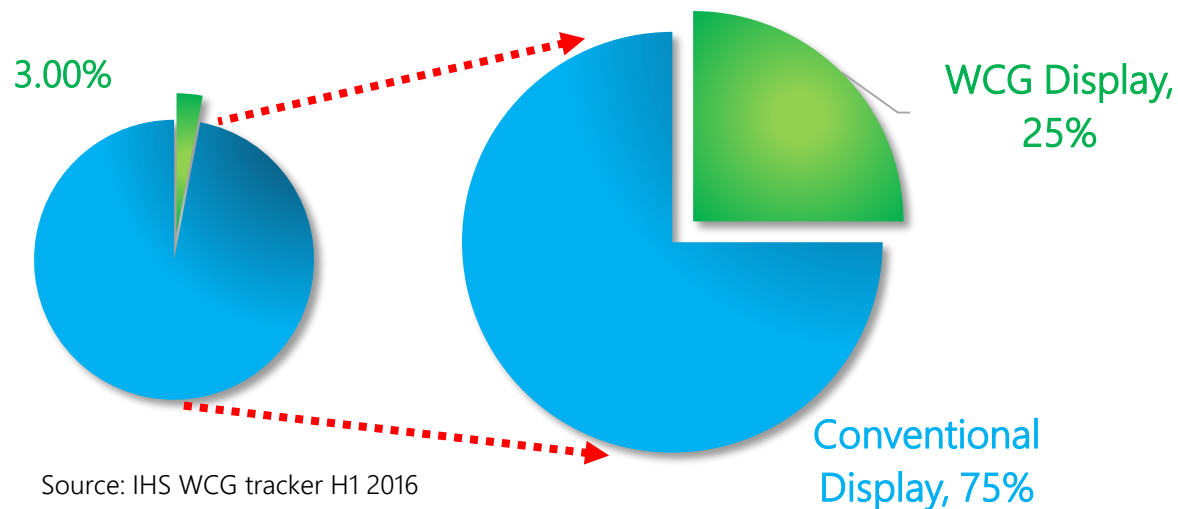


**DISPLAY**

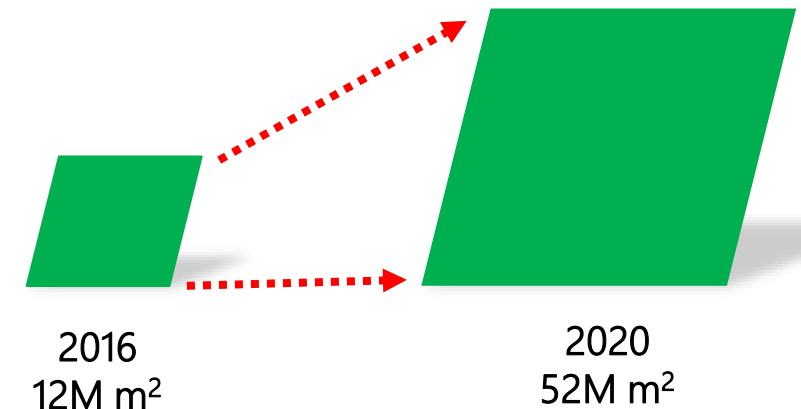
# WCG: THE NEW OPPORTUNITY

- Brands need to differentiate in order to maintain profitability
- Good growth in **WCG** display demand is expected to continue with **UHD** adoption
- Huge opportunity for innovative brands to establish themselves in the growing sector

## Total display market share of WCG by 2020



## WCG display area shipped by 2020



- Cadmium-free Quantum Dot technology is leading WCG growth due to its ability to sustainably and cost effectively add value and command premium pricing

# GROWING MARKET FOR CFQD

- Benefits of CFQDs
  - WCG displays for 4K, UHD, HDR, gaming, streaming, photos
  - Integrated into existing LCD technology – one of the most cost effective solutions (QD films)
  - Consistent and accurate colours across product range
  - Lightning fast response times and refresh rates
- IHS report that 26m displays will be QD equipped by 2021 and 90% (24m) will be cadmium-free
- 24m CFQD Displays would require c. 24 tonnes of CFQDs assuming 1g per m<sup>2</sup> of film; supply today limited to three manufacturers



**AUO demonstrating 8K & 4K  
65", 75" and 85" UHD HDR  
cadmium free QD TVs at Touch  
Taiwan in September 2017**

# MULTI-CHANNEL STRATEGY FOR DISPLAY

## Nanoco Non- exclusive Licensees



- Licence fee, royalties on sales of Merck produced product
- Merck evaluating large scale production options



- Revenue from Runcorn produced CFQD resin + royalty
- Focus on worldwide display OEMs



- Royalty on Dow sales
- South Korean factory producing & selling commercial quality CFQDs

## Potential Display Customers































# DISPLAY COMMERCIALIZATION

- AUO showed line of next generation 8K and 4K TVs equipped with Nanoco CFQD Fine Colour Film at Touch Taiwan
- Film produced from CFQD's produced by Nanoco in the UK and coated onto film by Wah Hong in Taiwan



65" CFQD 4K TV



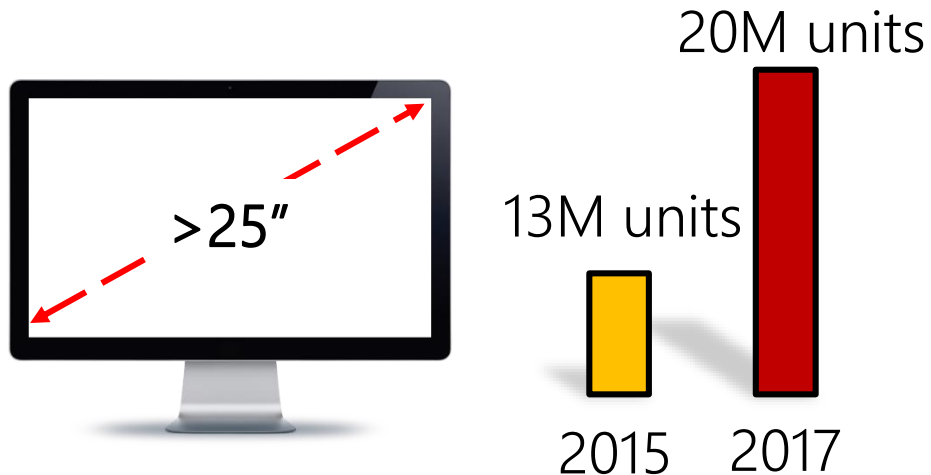
85" CFQD 8K TV



75" CFQD 4K TV

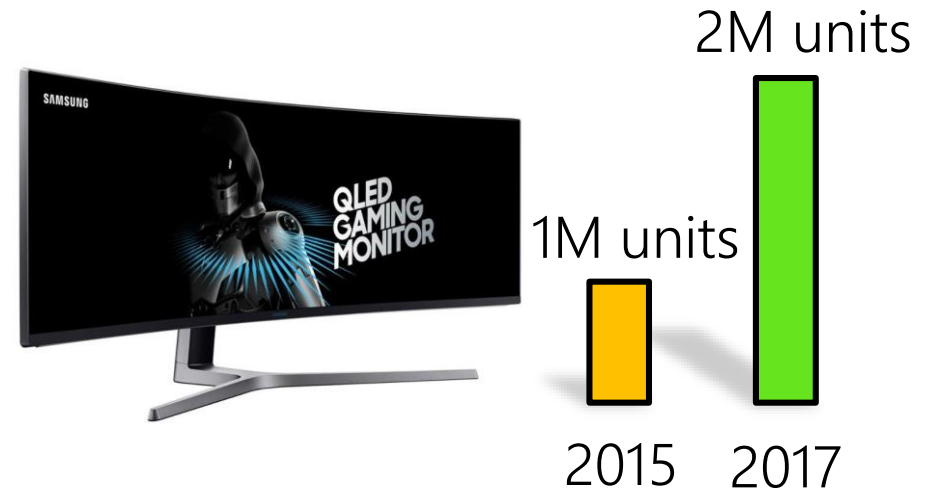
# MONITOR MARKET IS SHIFTING

- Increasing growth in >25" monitors, from 13M to 20M by end of 2017



- UHD sets to increase to 13% share of >25" in 2017

- Gaming monitor:
  - 3.9% of monitor market by 2017
  - 2M sets expected in 2017



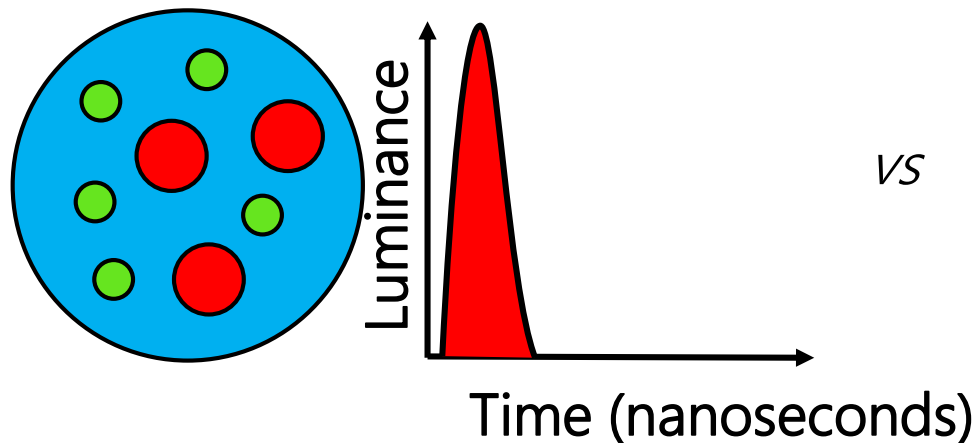
- HDR10 monitors just getting started:
  - 400K units in 2016
  - HDR10 penetration will mirror UHD/DCI monitor growth

# CFQD RESPONSE TIME

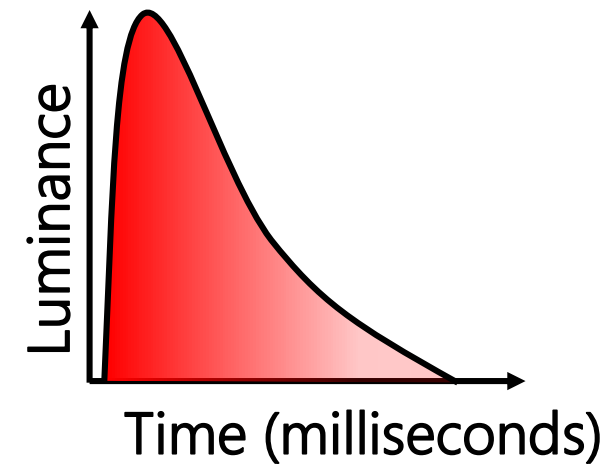
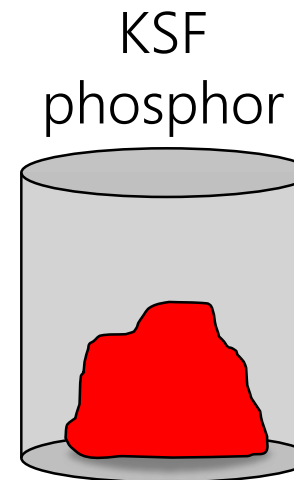
- TVs & monitors moving to High Frame Rate (HFR) with 144hz & above
- CFQD® quantum dots has response time of nanoseconds → display is not limited by the material
- In comparison KSF/red phosphor has decay time of 13 milliseconds
- CFQD® films are the ultimate HDR, HFR, UHD & wide colour gamut solution

## Comparison:

CFQD® quantum dots



VS



**1,000,000 X faster response time**

## QD Film

- Continuous improvement in CFQD quality to meet display demands
- Aggressive reduction of COGS

Current technology

## QD Colour Filter

- QD enabled colour filters for LCD TVs
- Improved colour gamut, brightness and viewing angle

3 – 5 years away

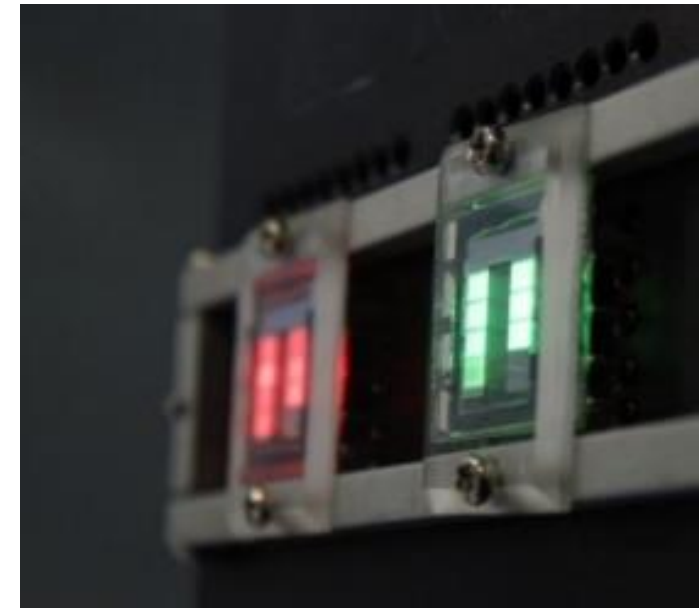
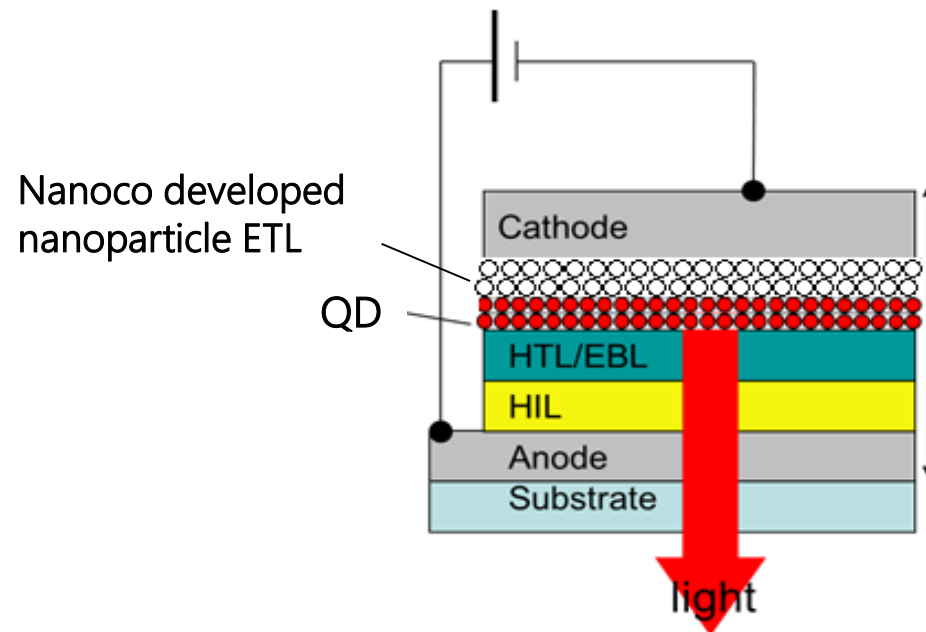
## QLED (EL-QD)

- EL QD
- Nanoco / Kyulux agreement
- Direct competitor to OLED

5+ years away



- Solution processing is a game changer for display
- Ease of manufacturing – high throughput, large scale
- Compatibility with lightweight, flexible substrates
- Requirements of CFQD® quantum dots for PL applications are different to those for EL applications
- Specific tailoring of materials for EL applications required



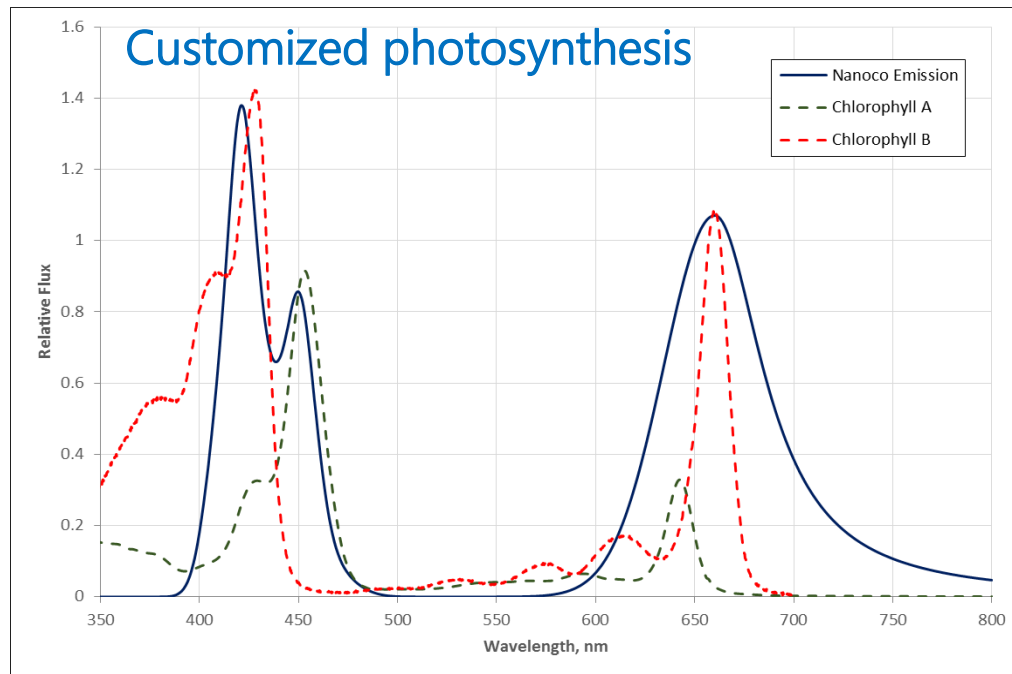
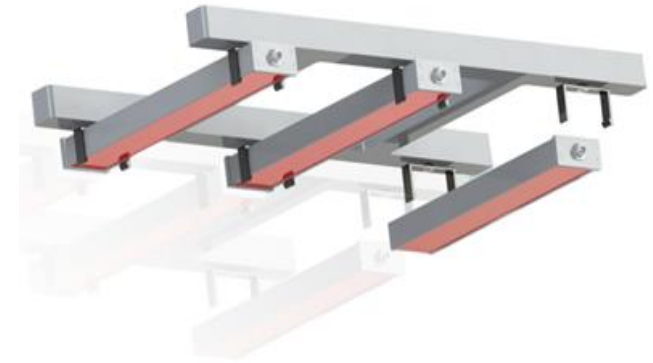


**OTHER MARKETS**



# LIGHTING FOR HEALTH CARE & HORTICULTURE

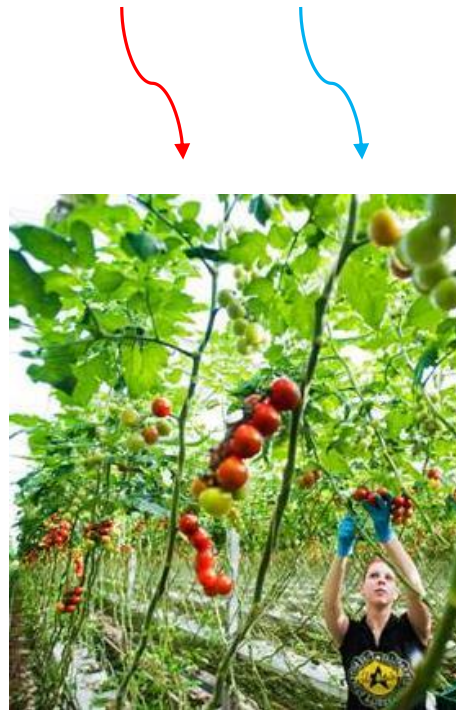
- Nanoco lights won CES 2017 Innovation Award
- Agricultural, health care and beauty
- Easy product integration & colour tuneable
- Customisable film sizes and shapes



- Each of these molecules absorbs at slightly different wavelengths with marked deviations in the near UV and far-red
- Tuneable QDs allow for the red emission of lamps to be tuned precisely for optimal growth and different life stages of the plant

Blue LEDs combined with red CFQD® quantum dot film, to only emit the colours of light needed for plant growth

Unlike other light sources that filter out the green light, the green light is not wasted but converted into useful red light

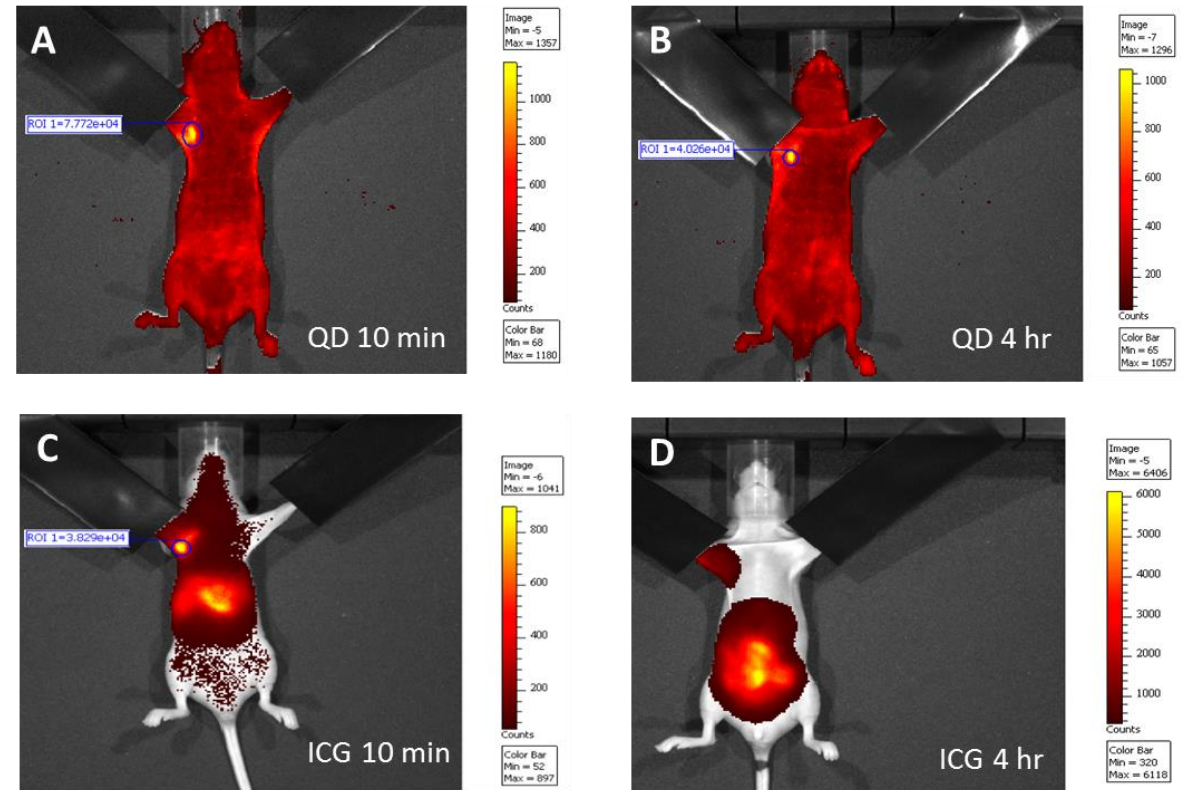


## Advantages

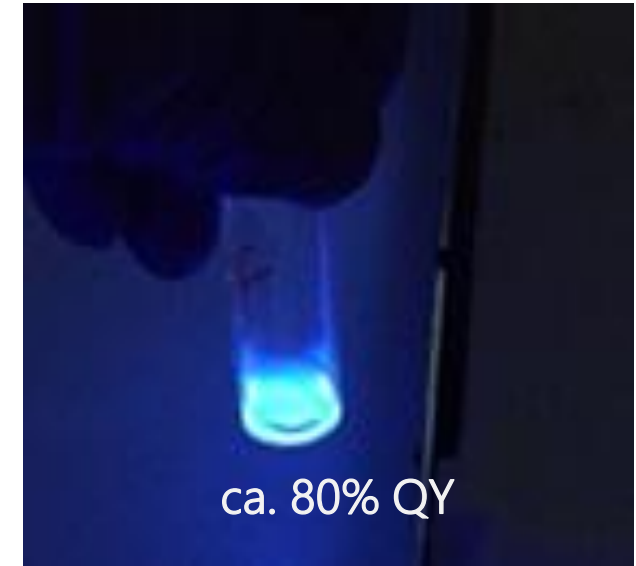
- Quicker plant growth
- Higher production yields
- Space saving
- Year round (non-seasonal) growth
- Can control photomorphogenesis – patterns in plant development triggered by light
- Improved taste



- Focus on in vivo imaging, diagnostic and targeted therapy of cancer
- Positive results shown including:
  - No signs of toxicity were observed in rodents after high IV doses
  - Vastly improved tumour demarcation when compared to industry standard dyes (ICG)
- Strong IP portfolio on functionalization and novel applications
- Extensive QC system & toxicology testing are on going



- Nano material development is a core competency of Nanoco
  - Complex particle design and development
  - Partnership between Nanoco and National Graphene Institute, UK led by Nobel Laureate Prof. Kostya Novoselov & Dr. Nigel Pickett
  - Funded through collaboration agreement
- Infrared, electroluminescent and other materials
  - IR materials for range of near term applications
  - New generation of electroluminescent QDs which compete directly with OLED materials for new generations of display
  - Complex combination of materials in partnership with world leading technology companies, e.g. Kyulux





# SUMMARY

# SUMMARY

- Platform technology with multiple, large addressable markets
- Extensive and growing patent portfolio
- Efficient mass production process with own manufacturing capability established and scaled
- Display – first commercial market
  - Hybrid commercial model established with multiple routes to market via own manufacturing and licensees
  - First display sales orders achieved and substantial pipeline of commercial opportunities
  - Products successfully displayed at Touch Taiwan and CES
  - Next gen products in development
- Other markets – opportunities emerging in Lighting, Life Sciences and Medical Devices
- Cost base significantly reduced and balance sheet strengthened







## **Nanoco Group PLC**

46 Grafton Street, Manchester, M13 9NT, United Kingdom,  
Tel: +44 161 603 7900 | Fax: +44 161 603 7901  
[info@nanocotechnologies.com](mailto:info@nanocotechnologies.com)  
[www.nanocogroup.com](http://www.nanocogroup.com)