TITLE : DEVELOPMENT OF NANO-SENSOR FOR HALAL AUTHENTICATION IN FOOD

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Introduction - Background

Definition of *Halal* –
Halal foods are foods that Muslims are allowed to eat or drink under Islamic Law that specifies what foods are allowed and how that food must be prepared : *Halal* means proper and permitted [1].

Increased concern –
In obtaining *Halal* food and beverages products in Muslim majority and minority part of an area.

Rising issue –
Food adulteration in food industry.

As an example –
The use of cheaper meat products such as pork, in chicken/beef meatball manufacturing, as an effort to lower down the production price and at the same time to improve the taste of the meatball in a cheap way [2, 3].

Introduction – Aim and Objective

Aim – Integrating nano-electronics & nano-photonics application towards the detection of the *Halalness* of food products.

Objective – Devising a hand-held portable nano-sensor to authenticate the presence of animals DNA in food products.

Nanotechnology at a Glance

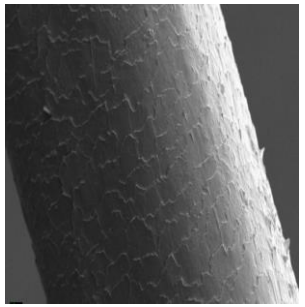
In general – Exploring and exploiting unique phenomena of materials at atomic, molecular and macromolecular scales to create materials, devices and systems with new and useful properties and function.

In short – the use of structures between 1 nanometer (nm) and 100 nanometers in size.

Significance - Very high surface areas**.**
- properties differ significantly from those at larger scale.

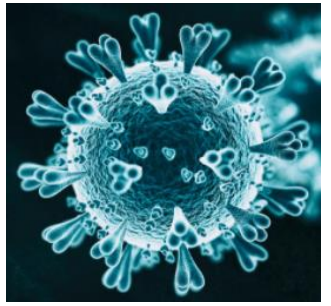
Height of goal post = 2.4 m

Fly = 7 mm

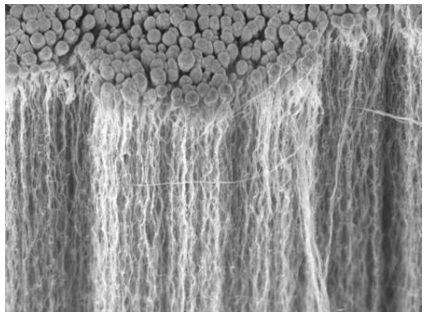


Human hair = 75 µm

Red blood cell = 7 µm



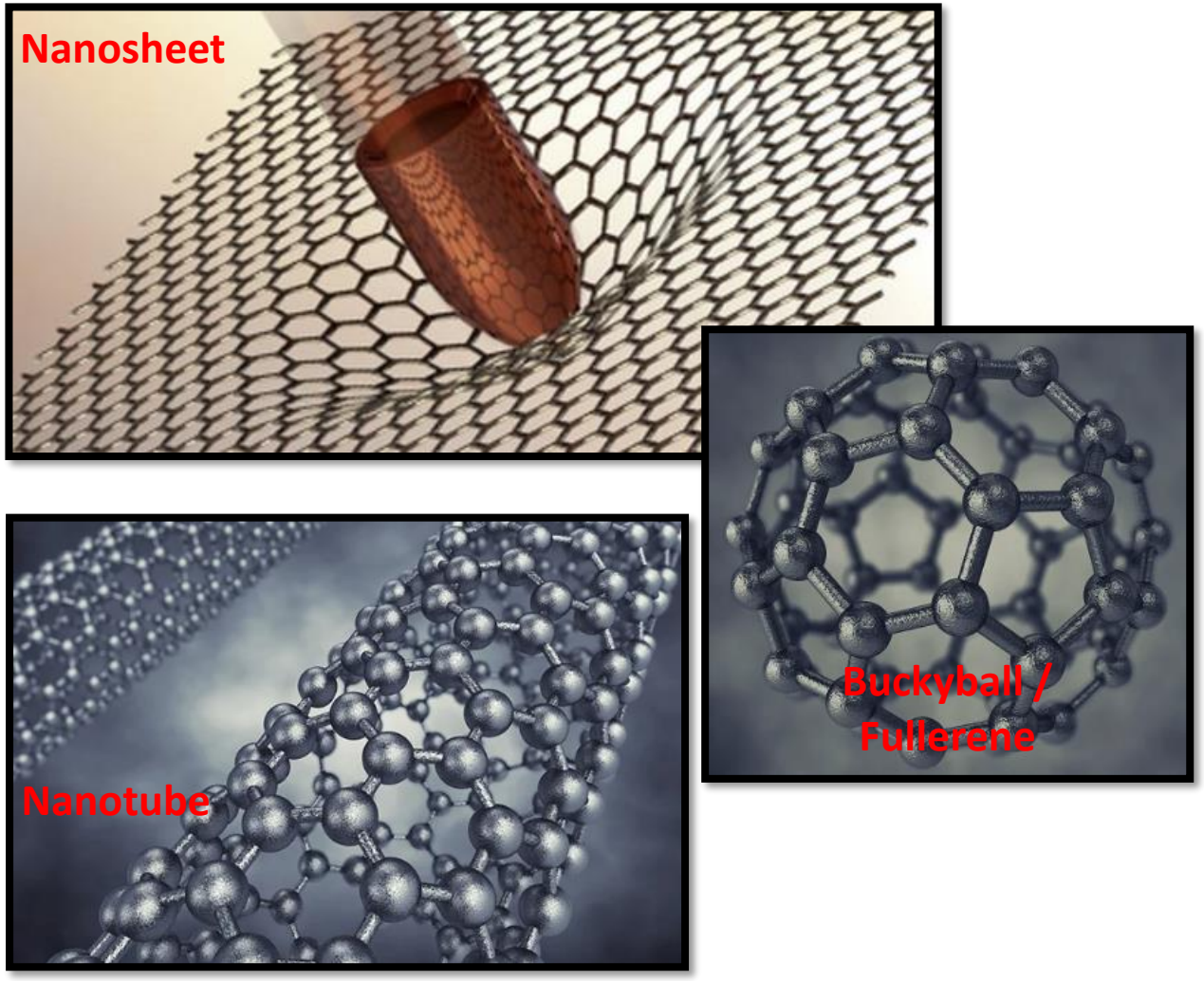
Corona virus = 140 nm



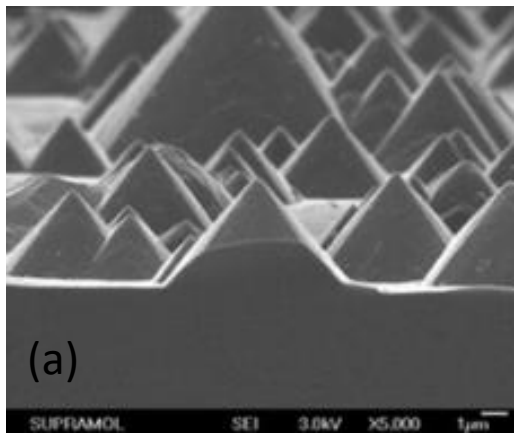
Carbon nanotube = 0.4 – 40 nm

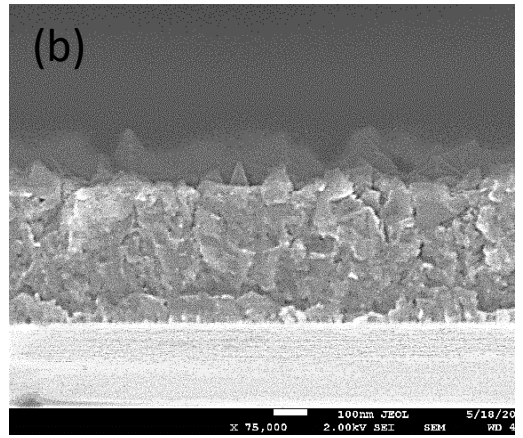
Nanotechnology at a Glance

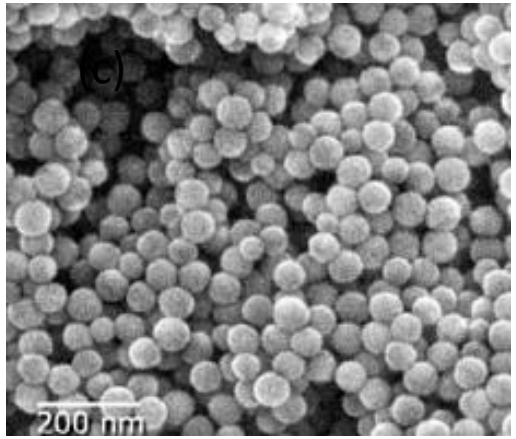
Carbon/Graphene Nanostructures



Silicon Nanostructures







SEM image of:

(a) nanopyramid crystalline silicon,

(b) grains of polysilicon,

(c) nanoparticles silicon dioxide.

How Our Life Revolves Around Nanotechnology?

Data centre

Superfast/High bandwidth telecommunication

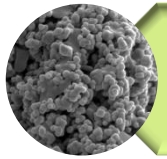
Renewable energy - Solar panels

Food packaging

Smart phones/ tablets

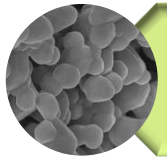
Medical

Nanotechnology in Food Industry



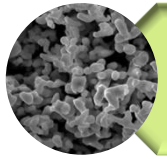
Food Ingredients for Color, Texture and Flavor

TiO_2 and SiO_2 nanoparticles



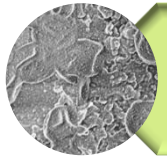
Food Production and Packaging

ZnO and MgO nanoparticles



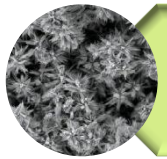
Nutrients and Dietary Supplements

Nanomaterials for enhanced absorption



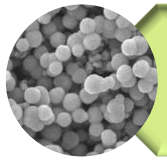
Food Storage

Antimicrobial nanomaterials



Food Nanosensors

Nanomaterials used in sensors to detect contamination



Food Safety

Tracking, tracing and brand protection

Nanotechnology in Food Industry

Nima: A portable sensor allows consumers to test food for gluten.

TellSpec: A hand-held scanner that offers real-time food testing, food-safety and food-authenticity.

PH200: Portable Meter Kit for Meat.

Nanotechnology for Halal Authentication

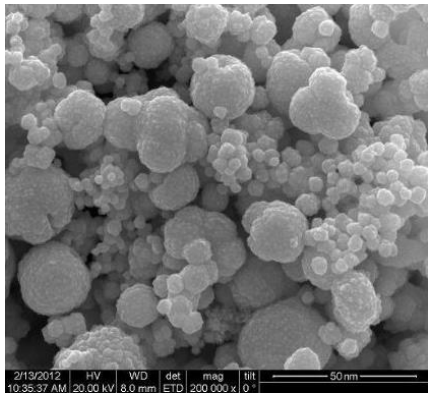
Concern in obtaining Halal foods has risen among the Muslim community, especially Muslim minorities in certain part of an area. The concern is escalated due to the increase in the use of cheaper meat products, such as pig, as a substitution to properly slaughtered Halal meat resources, such as cow [2,3].

Nanotechnology has shown great potential as a platform in sensing the *Halalness* of meat and beverages products.

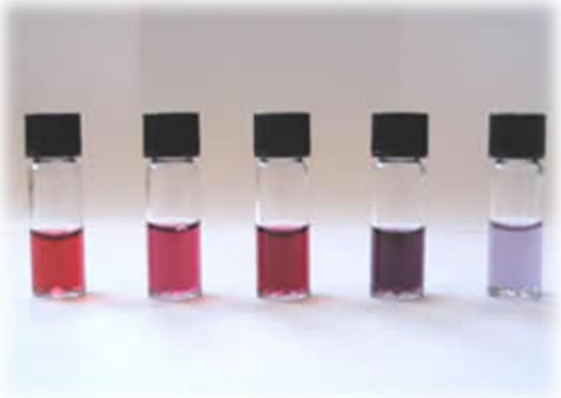
Reported a number of works on the use of Nanotechnology:

Detection of meat products using gold (Au) nanoparticles as colorimetric sensors – based on colour changed due its optical properties [4,5].

3D gold (Au) nanoparticles.

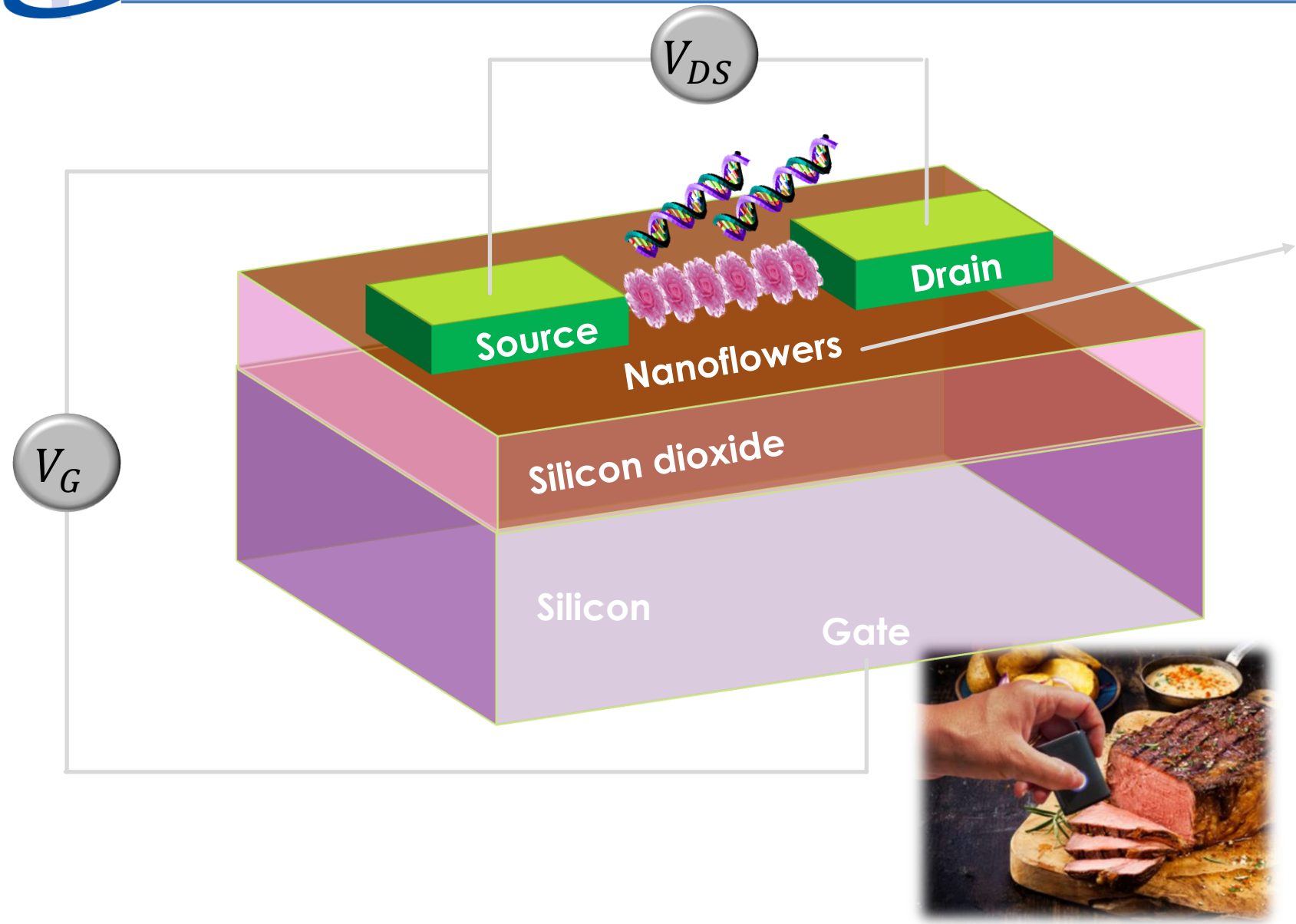


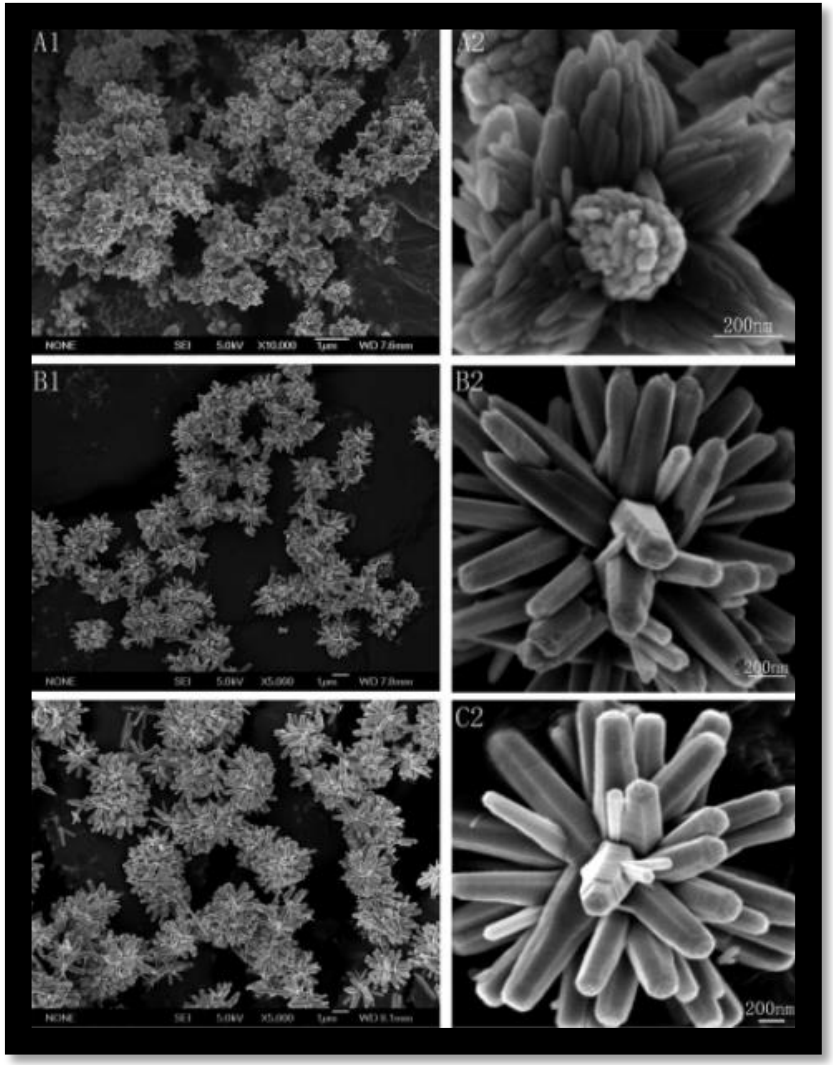
SEM of gold (Au) nanoparticles.



Colors of gold (Au) nanoparticles solution with various meat contents [4,5].

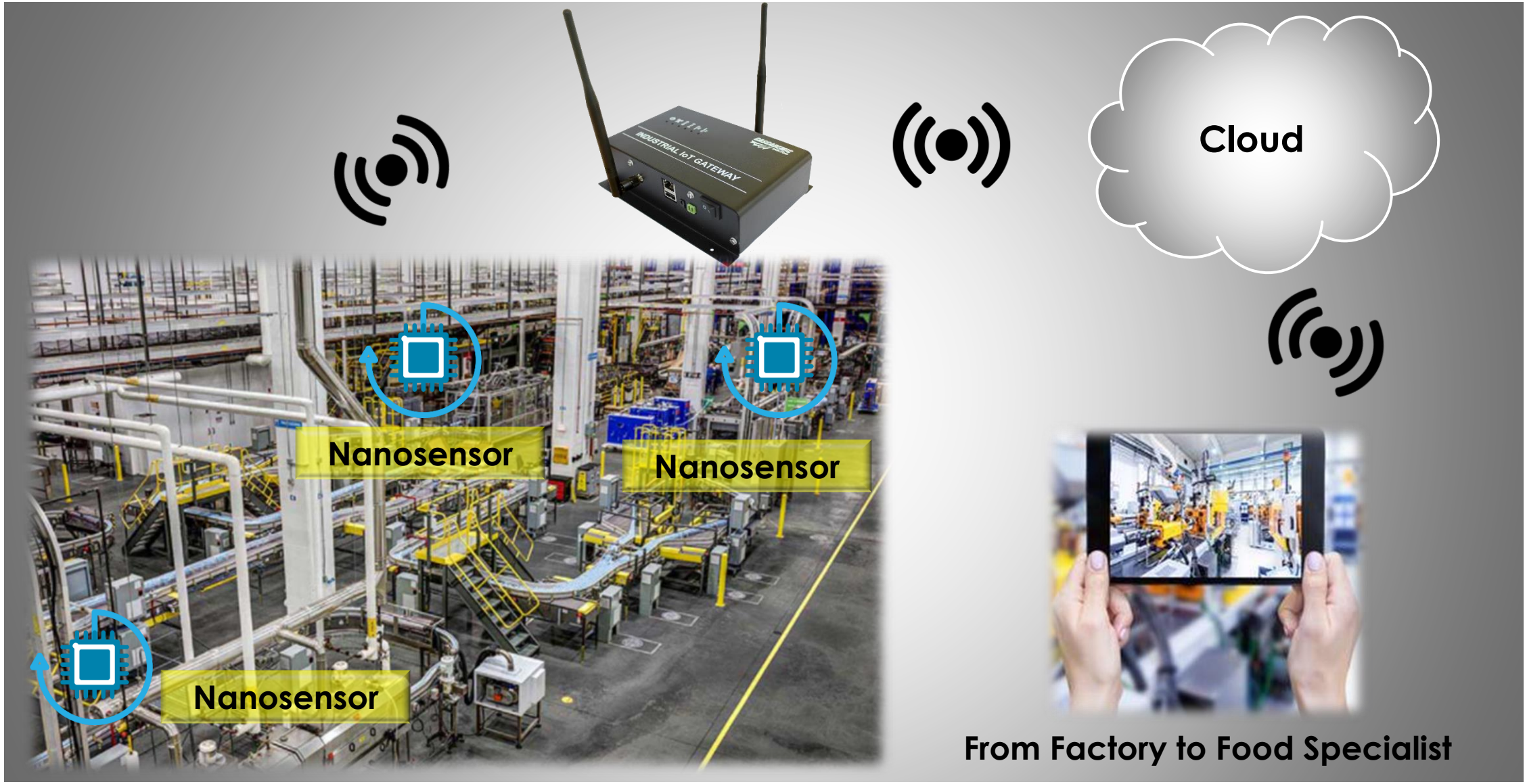
Nanotechnology for Halal Authentication





SEM images of ZnO nanoflowers (on carbon conductive tape).

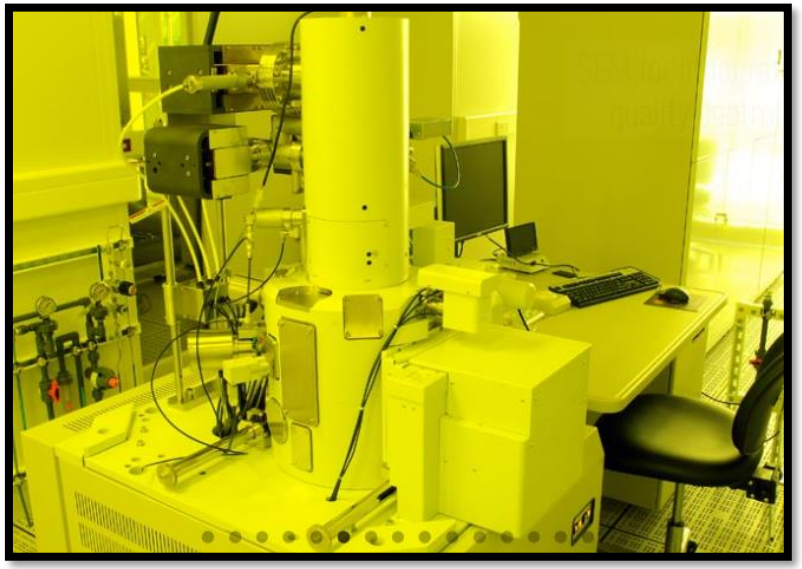
Nanotechnology for Halal Authentication



Cleanroom Facilities

Controlled level of contamination: specified by the number of particles/m^3.

ORNL researchers used a new scanning transmission electron microscopy technique to sculpt 3-D nanoscale features in a complex oxide material
(Credit: Department of Energy's Oak Ridge National Laboratory).



Device Fabrication at a Nanofabrication Centre

A cleanroom - has a **controlled level of contamination**, specified by the number of particles per cubic meter.

Example of pollutants contamination - **dust, microbes and chemical vapours**.

Most importantly - control other environmental parameters such as **temperature, humidity and pressure**.

Ambient outside for typical city = 35,200,000 particles per cubic meter.

Ambient in cleanroom = 35,200 particles per cubic meter.

Ambient in cleanroom = **1000 times** cleaner than **outside ambient**.

Process Development

1. Selection of material, fabrication and characterisation to final device.

2. Sample preparation – cleaning & surface conditioning of wafer. Common chemical used are FNA, RCA and HF. Strong acids are used to clean off any organics particles or general dust sticking on the wafer.

3. Low or high temperature treatment (250^{o}C to 350^{o}C) – to remove excess moisture.

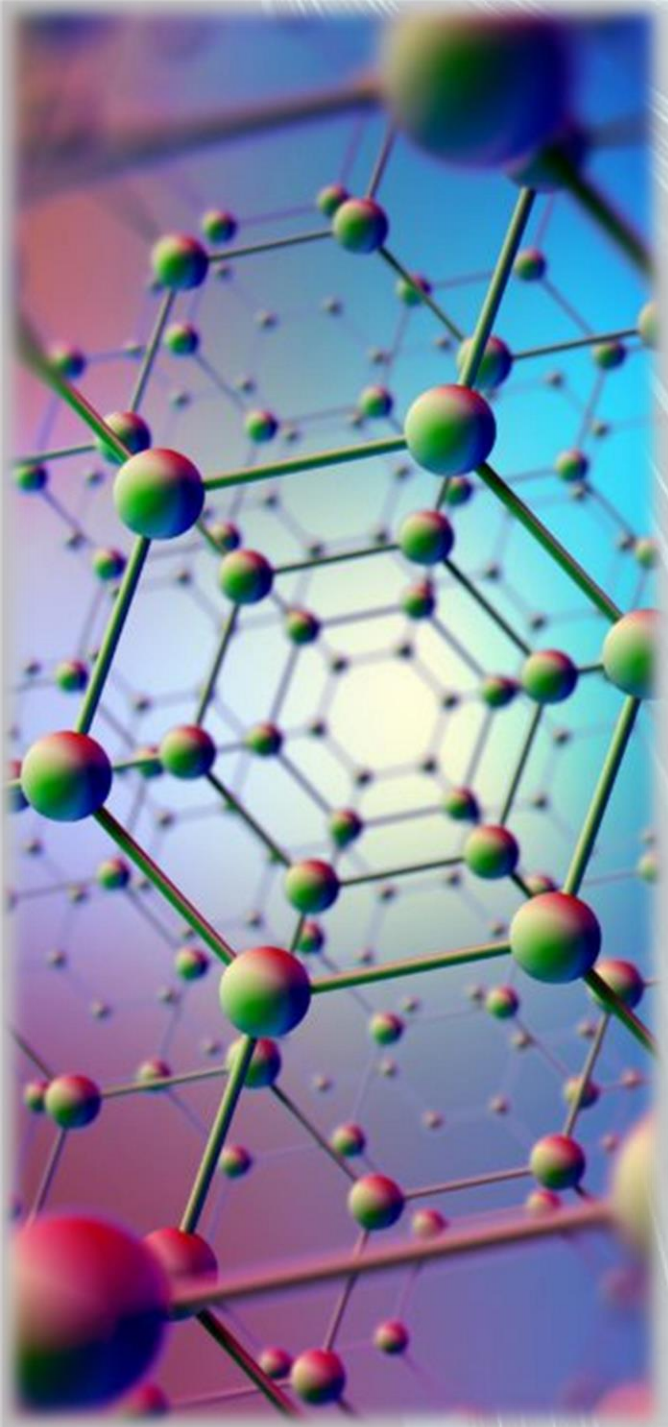
4. Deposition process –adding films to fabrication process. Examples are PECVD, LPCVD, HWCVD, sputtering, evaporation.

5. Pattern transfer – photolithography or electron-beam (e-beam) lithography.

6. Etching process – dry or wet etching.
Dry etching: isotropic or anisotropic profile. Slow rate but high quality.
Wet etching: crystal plane orientation. Fast rate but low quality.

Conclusion

- The objective of this project is to bridge the gap between electro-photonics and Halal Science to design and fabricate a sensor to detect the presence of specific animal DNA.
- The structure is adapted from a reported gas sensor, in this case utilizing nanostructured material as the sensory component, such as zinc oxide nanoflowers to detect the targeted animal DNA [5-8].
- We proposed to design a hand-held portable product for Halal application, similar to other commercialised food ingredients detector.
- Once developed, it is proposed to integrate the portable Halal authenticator sensor with an IoT application to be implemented in food factory for remote monitoring.
- The proposed project revolves around the 17 elements of the Sustainable Development Goals (SDGs) - to provide integrated solutions to the challenges the global community is facing, in terms of food security, reduced inequalities, responsible consumption & production, while ensuring inclusiveness and strong partnership among the global society.



Thank you for your kind attention

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