5.2 Non-thermal in Food processing

Non-Thermal Processing:

High-Pressure Processing (HPP):

HPP involves subjecting food products to high pressures to eliminate harmful microorganisms. This method retains the nutritional quality and sensory attributes of the food while extending shelf life. Commonly used for juices, meats, and guacamole.

Pulsed Electric Field (PEF):

PEF involves applying short bursts of electrical energy to food products, creating pores in cell membranes to inactivate microorganisms. This non-thermal method is used for liquids and semi-liquids, preserving the freshness and nutritional content.

Ultrasound Processing:

Ultrasound technology uses high-frequency sound waves to disrupt cell walls and membranes of microorganisms, achieving microbial inactivation. It is employed in liquid and semi-liquid products, enhancing safety without compromising product quality.

Cold Plasma Treatment:

Cold plasma, ionized gases containing reactive species, is used to disinfect food surfaces. This non-thermal method helps in reducing pathogens and extending the shelf life of products like fruits, vegetables, and meat.

Other Alternate Thermal Processing:

Microwave Processing:

Microwaves generate heat within food products by exciting water molecules. This rapid and targeted heating is particularly useful for thawing, cooking, and pasteurizing.

Ohmic Heating:

Ohmic heating passes an electric current through food, generating heat from within. This method is efficient for liquid products and preserves the quality of heat-sensitive components.

Infrared Heating:

Infrared heating uses electromagnetic radiation to heat the surface of food directly. This method is effective for browning, roasting, and drying processes.

Nanotechnology in Food Processing:

History of Nanotechnology:

The concept of nanotechnology was first introduced by physicist Richard Feynman in his 1959 lecture, "There's Plenty of Room at the Bottom." However, the term "nanotechnology" was officially coined by Professor Norio Taniguchi in 1974. Early developments were mostly theoretical until the advancement of microscopy techniques allowed scientists to manipulate materials at the nanoscale.

Fundamental Concepts of Nanotechnology:

Nanoscale Dimension:

Nanotechnology operates at the nanoscale, where unique properties emerge due to quantum effects. It typically involves structures with dimensions ranging from 1 to 100 nanometers.

Quantum Mechanics:

Quantum mechanics governs the behavior of particles at the nanoscale, impacting electronic, optical, and magnetic properties. Quantum phenomena become more pronounced, influencing the physical and chemical characteristics of materials.

Bottom-Up and Top-Down Approaches:

Nanofabrication techniques involve both bottom-up (building from individual atoms or molecules) and top-down (scaling down larger materials) approaches.

Self-Assembly:

Self-assembly is a key concept in nanotechnology, where materials spontaneously organize into specific structures. This mimics natural processes and is utilized for creating nanoscale patterns and devices.

Tools and Techniques in Nanotechnology:

Scanning Tunneling Microscope (STM):

Invented in 1981, the STM allows scientists to visualize and manipulate individual atoms on surfaces, providing unprecedented insights into nanoscale structures.

Atomic Force Microscope (AFM):

AFM measures forces between a sharp probe and nanoscale surfaces, enabling detailed imaging and analysis of materials at the atomic and molecular levels.

Transmission Electron Microscope (TEM):

TEM uses electrons to image ultra-thin sections of materials, offering high-resolution views of nanoscale structures.

Nanolithography:

Nanolithography techniques, including photolithography and electron-beam lithography, are used to pattern surfaces at the nanoscale, essential for the fabrication of nanodevices.

Nanomaterials:

Nanoparticles:

Nanoparticles are particles with dimensions in the nanometer range. They exhibit unique properties and find applications in drug delivery, imaging, and catalysis.

Carbon Nanotubes:

Carbon nanotubes are cylindrical structures made of carbon atoms. They possess exceptional strength and conductivity, making them valuable in electronics, materials science, and nanomedicine.

Quantum Dots:

Quantum dots are semiconductor nanocrystals with size-dependent optical properties. They are used in displays, solar cells, and biological imaging.

Nanocomposites:

Nanocomposites combine nanoparticles with bulk materials, enhancing mechanical, thermal, or electrical properties. They are utilized in various industries, including automotive and aerospace.

Nanotechnology in food processing and its applications in non-thermal processing methods offer innovative solutions to improve food safety, quality, and sustainability. As the field continues to advance, the integration of nanomaterials and nanotechnological tools promises to revolutionize multiple industries.