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Letter to Editor

Microwave and its advancements

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INTRODUCTION

Microwaves travel line of sight, unlike lower frequency radio waves and its photon energy is around 1.24 meV – 1.24μeV. They are form of electromagnetic waves with wavelength longer than that of terahertz wavelength but comparatively short for radio wave. Nevertheless, the boundaries among far infrared light, terahertz radiation, microwaves and ultra-high frequency radio waves are subjective and are used in wide range between various fields of study.[1, 2]

Few of them below are discussed from abundant sources of Microwaves applications which will help to move further with the research and development.

Silicon Technology can make Microwave Technology better and much economical

Microwaves are usually generated by a device called Gunn diodes which take advantage of exclusive properties of expensive and noxious semiconductor materials like gallium arsenide. When a voltage is applied to gallium arsenide and then increased electrical current through it also increases but only to a certain limit. Beyond that point, current decreases and known as Gunn effect that results in the emission of microwaves.

Silicon is the second most abundant substance on earth. It would be easy to work with manufacturing and costs about one-twentieth as much as gallium arsenide. This new technology involves silicon nano wires that are so tiny that it would take around 100,000 of them collected together to an equal thickness of a human hair. Complex computer models have been presented that if silicon nano wires are stretched and voltage is applied to them, the Gunn effect and emission of microwaves can be made.

"With this new technology of new nano-fabrication methods, it is now easy to shape bulk silicone into nano wire fabrication" was confirmed by Shiri.[3,4]

Pasteurization of milk with Microwaves

In order to increase the shelf life of fresh milk and eliminate spoilage by microorganisms, milk is typically heated in a process called pasteurization. Cold milk is preheated and further heated in different section for a few seconds up to 72 degree Centigrade. The major microorganisms are eliminated in this process and as result, milk can be kept usable up to ten days. However, direct heating milk using plate exchangers has disadvantages; heat transfer is deteriorated by a process known as fouling.

In EU project development Micro Milk, coordinated by Fraunhofer Institute for Interfacial Engineering and Biotechnology (IGB) with other partners have developed a system that enables preservation of milk and milk products with microwaves. In this method, the core of the microwave method and a result of the extensive simulation is a compact reactor which is divided into various compartments. Each compartment is fitted with its own magnetron generating electromagnetic waves. And in the second microwave pasteurization unit to be built that has a flow rate of 1000 liters per hour and will be tested to consider particularly high viscous products like condensed milk and whey concentrates.[5]

Microwaves for quantum reservoir

Microwaves are the backbone for several, everyday technologies from microwave ovens, cellular phones to satellite communication and it recently gained further importance in employing in quantum information in superconducting circuits; one of the most rising contenders to recognize future quantum computers.

Micro drum that is 30 microns in diameter and 100 nanometers thick and is manufactured in the Center of Micro Nanotechnology (CMi). It comprises of the top plate of a capacitor in a superconducting microwave resonator. In this drum's position, there is resonance modulator that resonates and conversely effects voltage across the capacitor that applies a force on the micro drum. Through this bidirectional collaboration, energy can be transferred between mechanical vibrations and the microwave oscillations in the superconducting circuit.

In this research, the micro drum is first cooled close to its lowest energy quantum level by an appropriately tuned microwave tone (Figure 1). Every microwave photon transports away the energy of a phonon (which is a quantum of mechanical motion) such that the mechanical energy is reduced. This cooling method increases the dissipation and turns the micro drum into a dissipative reservoir for the microwave resonator.

"There has been a lot of research and experiments on bringing mechanical oscillators into the quantum in past few years" was told by Dr. Alexey Feofanov, a postdoctoral researcher on the project.[6,7]

Microwaves to produce High-Quality Graphene

Graphene is 100 times tougher than steel, conducts electricity better than copper and dissipates heat rapidly; making useful for many applications. Large-scale fabrication of graphene is essential for applications such as printable electronics, electrodes for batteries and catalysts for fuel cells.

The easiest way to make huge quantities of graphene is to exfoliate graphite into distinct graphene sheets using chemicals. The disadvantage of this method is that reactions occur with oxygen forming graphene oxide that is electrically non-conducting which makes it less useful for products.

Chhowalla and his team members found that baking the exfoliated graphene oxide (Figure 2), for one second in a 1000 watt microwave oven and eliminating virtually all of the oxygen from graphene oxide.[8, 9]

Researchers designed invisible objects in the Microwave range without Metamaterial Cloaking

Researchers studied light scattering from glass filled with water. In their experiment; represents a two dimensional analog of a classical problem of scattering from a homogeneous sphere. Nevertheless, this classical problem contains unusual physics that demonstrates itself when materials with high values of refractive index are involved. In this research, they used ordinary water whose refractive index can be regulated by changing temperature. As it turned out, high refractive index is associated with scattering mechanisms which is related to localization of light inside the cylinder and non-resonant which is categorized by even dependence on the wave frequency. This interaction between these mechanisms is stated as Fano resonances. They also discovered that certain frequencies waves scattered through resonant and non-resonant mechanism have completely reverse phases and are mutually destroying thus making the object undetectable.

Physicists from ITMO University (Figure 3), loffe institute and Australian National University designed a method to make homogenous cylindrical objects completely invisible in microwave range.[10, 11]

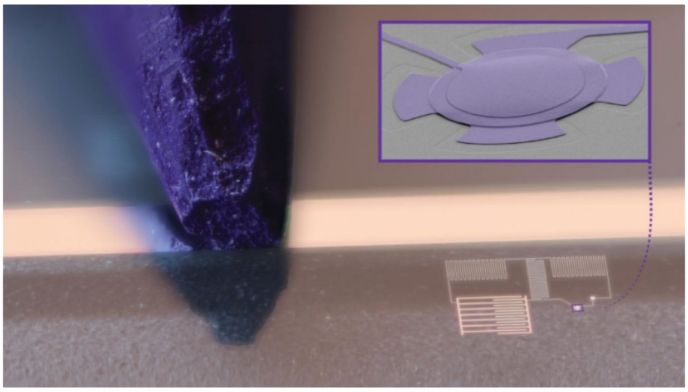

Figure 1. Illustrates the chip used in the experiment to couple a microwave cavity to micrometer size drum.[7] Image Credit: N. R. Bernier and L. D. Tóth (EPFL).

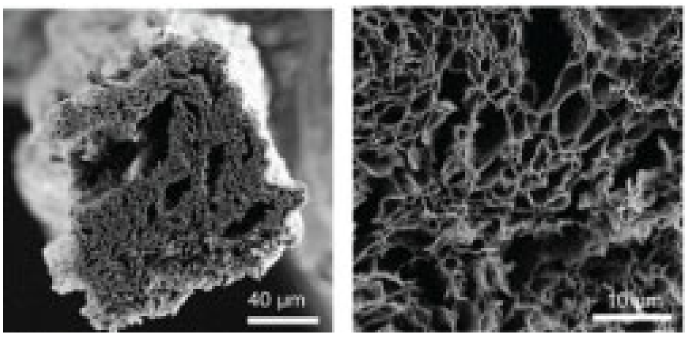

Figure 2. Illustrates scanning electron microscopy of a graphene fiber constructed from microwave reduced graphene oxide.[9] Image Credit: Jieun Yang, Damien Voiry and Jacob Kupferberg

Figure 3. Illustrates Radio frequency anechoic chamber used for the research.[11] Image Credit: ITMO University

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