

# Neurobiological Mechanisms and Perspectives on Far-Infrared Emitting Ceramic Materials for Pain Relief

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## DESCRIPTION

Pain is an important, evolutionarily conserved physiological phenomenon that is necessary for survival. At the same time, pain is one of the most frequent symptoms of a variety of pathological disorders and represents a major clinical challenge. Although the acute pain that accompanies minor tissue injury is protective, chronic pain typically persists long after injuries have subsided. Chronic pain is characterized by its long-term nature and abnormal sensitivity to thermal and mechanical stimuli and can take the form of hyperalgesia, an excessive reaction to a normally painful stimulus, or allodynia, a painful response to normally innocuous stimulus. Several types of physical therapy are used in the management of pain. These treatment modalities can be categorized as electrotherapy modalities, acupuncture, thermal modalities, exercise, manual therapies or phototherapy. In the last few years the biomedical research area is going towards materials science aiming applications of bioceramic materials to health care, the so-called Far-Infrared Emitting Ceramic Materials (cFIR). A recent promising development of cFIR is related to the field of pain. Bioceramics are refractory, inorganic, nonmetallic polycrystalline compounds that due to their inertness in aqueous conditions are highly biocompatible and thus have been extensively used in implants, but in the last few decades bioceramic materials have been studied for yet another property: Their ability to reflect/emit far-infrared. cFIR when reduced to powdered format can be incorporated in an array of products such as fabrics, all sorts of polymers and inks to create products that produces FIR which has been shown to present a gamut of health benefits, including analgesic, anti-inflammatory and anti-oxidative activities.

As direct result of the advances in cFIR research, in the last decade many companies started to implement cFIR medical items, such as belts, braces and patches, e.g., Thermomedic in Australia, Neomed in Korea, Shen Wan in China and BioPower in the United States and Brazil, to name but a few. These products are now being used by physical therapists and other health care professionals as adjuvant to more traditional approaches, mainly due to the fact that patients can extend the treatment effect, by simply wearing the products at home. To understand the health benefits of cFIR derived products, it is important to understand what FIR is as well as its benefits: FIR is a region in the infrared spectrum of electromagnetic radiation from 3 to 100  $\mu\text{m}$  (International Commission on Illumination classification of IR radiation) which has the ability to penetrate up to 1.5 inches (almost 4 cm) beneath the skin. Particularly in the range of 8 to 12  $\mu\text{m}$ , FIR has been shown to present many beneficial biological effects. FIR emitted by saunas and other FIR generators powered by electricity uses irradiances in the range of tens of  $\text{mW}/\text{cm}^2$  and is perceived as heat by the thermoreceptors in human skin; whereas FIR emitted by cFIRs, has such low irradiance (0.1-5  $\text{mW}/\text{cm}^2$ ) that is not enough to heat the tissue. Different from FIR devices powered by electricity, the source of energy that powers the emissions from the cFIR comes from the human body, which is normally at a higher temperature than the environment. In this process body energy is transferred to the ceramic materials, which reflect/emit FIR back to the body at varying levels depending on its molecular composition. The underlying mechanisms of the interaction of low irradiance FIR (such as the one emitted by cFIR) with living cells is not fully understood; it has been demonstrated that low irradiance FIR absorption causes the collapse of water clusters, and the energy transfer may be converted into molecular vibrations.

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**Received:** 05-Dec-2022, Manuscript No. JYPT-22-23901; **Editor assigned:** 07-Dec-2022, Pre QC No. JYPT-22-23901 (PQ); **Reviewed:** 21-Dec-2022, QC No. JYPT-22-23901; **Revised:** 28-Dec-2022, Manuscript No. JYPT-22-23901 (R); **Published:** 04-Jan-2023. DOI: 10.35248/2157-7595.22.12.365.

**Citation:** Francisco José Cidral-Filho ND, Martins DF (2022) Neurobiological Mechanisms and Perspectives on Far-Infrared Emitti Ceramic Materials for Pain Relief. J Yoga Phys Ther. 12.365.

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