Near-infrared photobiomodulation technique targets brain inflammation

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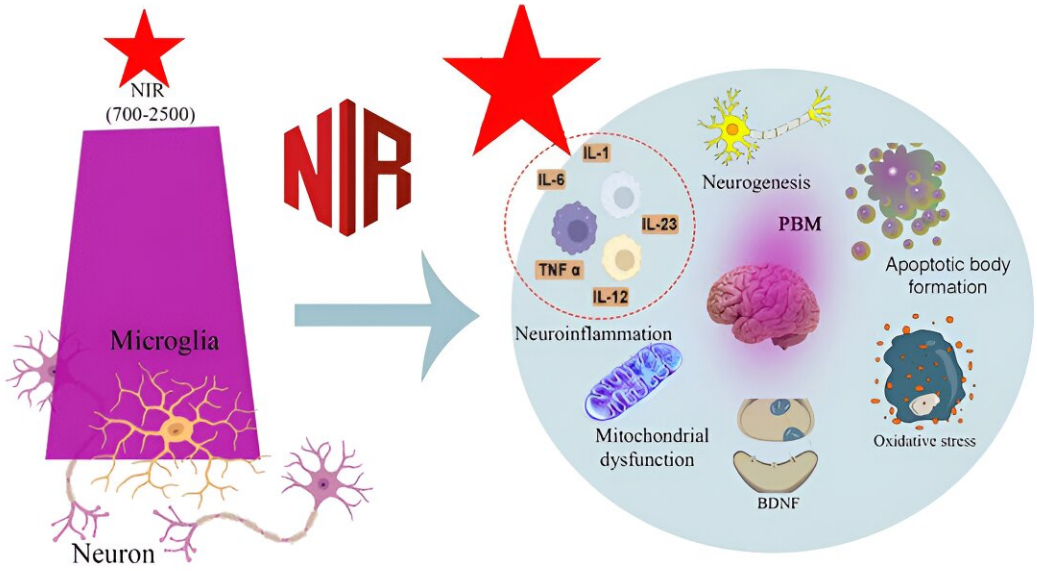


Photobiomodulation technique using a novel near-infrared (NIR) phosphor shows unprecedented promise in treating neurodegenerative diseases. Credit: Lei Chen (Hefei University of Technology).

As the world grapples with an aging population, the rise in neurodegenerative diseases such as Alzheimer's and Parkinson's is becoming a significant challenge. These conditions place a heavy burden not only on those afflicted but also on their families and society at large. Traditional treatments, including drug therapy and surgery, often come with side effects and high costs, and more critically, they fail to halt the

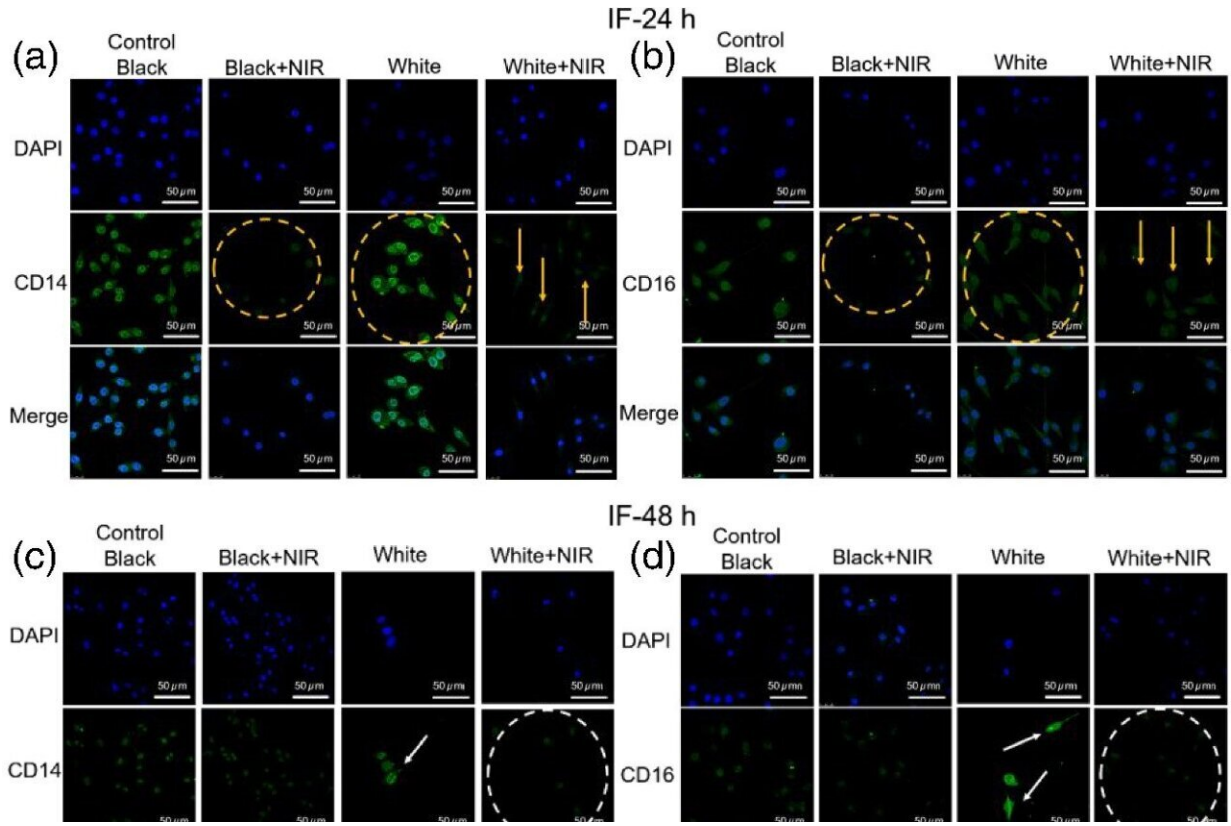
progression of neuronal degeneration or prevent the death of neurons in patients.

However, the field of photobiomodulation (PBM), which is emerging as a promising alternative to conventional treatments, shows promise. A recent study published in *Advanced Photonics Nexus* introduces a noninvasive photonic approach that could revolutionize how we combat these debilitating diseases.

The research, led by Prof. Lei Chen of Hefei University of Technology, Prof. Bo Wang of Wuyi University, and their colleagues from the Institute of Brain Diseases of the Shenzhen Institutes of Advanced Technology of the Chinese Academy of Sciences, focuses on the use of a special broadband near-infrared (NIR) phosphor, $SrGa_{12}O_{19}:Cr^{3+}$. This phosphor emits NIR light that can persist for over two hours after ultraviolet irradiation has ceased, offering sustained therapeutic benefits.

The team meticulously optimized the synthesis and composition of the phosphor, resulting in the creation of an optimal compound, $(Sr,Ba)Ga_{12}O_{19}:Cr^{3+}$, which was then used to package NIR LED devices. These devices demonstrated remarkable absorbance and quantum efficiency, with the optimal $Sr(Ga_{0.99}Cr_{0.01})_{12}O_{19}$ phosphor reaching 53.9, 99.2, and 53.5% respectively.

The luminescence performance of the phosphor remained high at 97.34% even at an operating temperature of 150°C. The LED devices encapsulated with this phosphor broke records, achieving an output power of 19.69 mW and an energy conversion efficiency of 37.58% at 20 mA, and 63.75 mW and 27.89% at 100 mA.



Immunofluorescence detection of BV-2 microglia in different light treatments. The broadband emission of the NIR LED device covers the absorption peaks of cytochrome c oxidase well, showing great promising for photomedicine application. Credit: Liu et al., doi 10.1117/1.APN.3.3.036008

The study's most significant finding is the potential of NIR light in suppressing neuroinflammation. By culturing BV-2 microglia and subjecting them to various light treatments, the researchers demonstrated that NIR LEDs encapsulated with the $SrGa_{12}O_{19}:Cr^{3+}$ phosphor could effectively regulate microglia cells from the overexcited M1/M2 phenotype to the resting M0 phenotype.

This transition is crucial as it alleviates, inhibits, or even reverses microglia inflammation. Furthermore, the NIR light was shown to

promote the proliferation of microglia, enhance the production of adenosine triphosphate (ATP), reverse overexcitation, reduce inflammation, and improve cell survival rates and activity.

The implications of this study are profound, suggesting that LEDs, with their broadband NIR emission and tunable wavelengths, could match the wide absorption band of biological tissues more effectively than laser light sources, leading to better therapeutic outcomes. This innovative photonic approach holds great promise for the future of photomedicine, potentially offering a noninvasive, cost-effective, and side-effect-free treatment option for millions of individuals suffering from neurodegenerative diseases such as Parkinson's, Alzheimer's, and ALS.

More information: Qi Liu et al, Suppressing neuroinflammation using the near-infrared light emitted by (Sr,Ba)$Ga_{12}O_{19}$: Cr^{3+} phosphor, *Advanced Photonics Nexus* (2024). DOI: 10.1117/1.APN.3.3.036008

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