

# Studies on Optical Properties of Cu<sub>2</sub>O Nanoparticles in a Sodium Borate Glass Matrix

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Cuprous oxide (Cu<sub>2</sub>O) is a promising inorganic compound with notable light-absorbing properties, making it a sought-after material for various applications such as sensors, efficient solar cells, and photocatalysis. It is a p-type semiconductor due to the negatively charged Cu vacancies, exhibiting a direct band gap between 1.9 and 2.2 eV. According to the literature, Cu<sub>2</sub>O presents a significant absorption coefficient from violet to green in the solar spectrum range. Its potential applications encompass sensors, efficient solar cells, and photocatalysis. Furthermore, semiconductor nanoparticles (NPs) have drawn attention due to their unique properties related to quantum confinement effects. The optical and electrical characteristics of these NPs are size-dependent. This enables control of their properties through the NPs growth processes, such as heat treatments. This study explores the optical properties of Cu<sub>2</sub>O nanoparticles integrated into sodium borate glass matrices, with a specific focus on assessing their suitability for photonics applications. The sodium borate glasses were synthesized by grinding and mixing the reagents, followed by melting in a furnace and cooling to create a molten material. These samples exhibit greenish hues. Subsequently, selected samples were subjected to different heat treatments, a stage in which nucleation and growth processes of Cu<sub>2</sub>O NPs occur, turning the samples darker in visible light. To analyze the optical properties, the study employed absorbance and photoluminescence measurements, providing insights into the material's light absorption and emission behavior. Additionally, a Tauc analysis was conducted to ascertain the optical band gap energy of the samples. Furthermore, nonlinear optical refraction was estimated through nonlinear ellipse rotation measurements, to investigate the material's potential for nonlinear optical applications. Transmission electron microscopy (TEM) micrographs of the samples were also obtained, providing visual evidence of the morphology and distribution of Cu<sub>2</sub>O nanoparticles within the sodium borate glass matrix. These are preliminary results in the investigation of the optical properties of these samples, aiming to provide insights into their practical photonics applications.

Keywords: Optical properties, Nanoparticles, Cuprous oxide