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Doses Dosimetry for Nanostructed Materials by Mean of Lyoluminescence

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Abstract

A group of organic and inorganic materials were selected to prepare nanostructures to study the phenomenon of lyoluminescence (light emission when radioactive solids are dissolved). The process of preparing nanostructures was done by thermal decomposition because it is an easy and inexpensive method that does not require advanced devices to prepare nanomaterials. The dosimeters were selected to be prepared on a nanoscale by reviewing previous studies for their high solubility and abundance, as well as their presence in the components of the human body. Sodium chloride, L-proline,L- glutamine, dextrin, and glucose dosimeters were used. Several tests were carried out on these materials, such as X-ray diffraction (XRD) to obtain the purchased material's diffraction data and matched them with the international central diffraction data (ICDD) of the material for the purpose of proving the identity of the material. After the nanostructures were prepared, their dimensions were measured using transmission electron microscopy (TEM), which showed that they have dimensions of less than 100 nm, which is the standard used to describe the nanoscale. The energy gap value of the nano and micro-materials was calculated from the optical spectra of the UV-visible absorption spectra. It was found that there is a decrease in the energy gap value of the nanostructures compared to the microstructures due to the change in their optical properties, except for sodium chloride, whose optical properties have not changed. The lyoluminescence phenomenon of these nanostructures was studied by exposing them to low and high radiation doses and comparing them with the fluorescence products of the microstructures. The periods of exposure of these structures to gamma rays using cobalt-60 result in an absorbed dose of 0.68–65.13 mRad, which is considered a low dose of ionizing radiation (LDIR) and is suitable for medical use. The lyoluminescence product of these used nanostructures is 103 times greater than that of the microstructures, as this shows their high sensitivity in measuring low radiation doses. This is due to the advantages shown by nanostructures, as their surface area is larger than their size, so the surface area for the interaction between the incident photon and the orbital electrons is large,

which leads to the production of a large number of free radicals, which is the main factor for the intensity of the resulting lyoluminescence. These Nano dosimeters can be used as equivalent tissues in medical studies by calculating their energy response as well as the mass energy absorption coefficient and comparing them with (soft tissue ICRU-44, muscle ICRU-44, and blood ICRU-44) used as references for comparison, where the percentage of matching is about 98% due to the great similarity in their structures. as well as using them as dosimeters for environmental purposes because they are highly sensitive to gamma radiation.