Photocatalytic Activity of Compositions of Type H_2O_2-TiO_2:S,C-HAp/FAp in Visible Light

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Recently, considerable attention is devoted to photocatalytic processes, mechanisms and the search new materials for photocatalysis processes. Oxide materials are effective to initiate catalytic reactions. Titanium oxide (TiO_2) has been a subject of considerable attention due to its semiconductor properties, photosensitivity in the ultraviolet light; high photocatalytic properties and applications to clean air, water, and decomposition of organic compounds, bleaching, disinfection and others.

However, using high-energy ultraviolet excitation is limited or unacceptable in some biomedical applications. Thus, there is important to create of photocatalytic materials sensibilized in the visible range of the spectrum. Hydrogen peroxide is widely used as a generator of free radicals in the process of bleaching and whitening. However, the concentration of hydrogen peroxide in biomedical applications strongly regulated or limited to 6%. The catalytic properties of calcium apatite, for example hydroxyapatite, which is a component of bone, are well known. Their nanoscale compositions are used in the processes of remineralization of dental hard tissues.

The main idea of this work is to create a catalyst composition consisting of nanostructured apatite calcium (hydroxyapatite (Hap), fluorideapatite (Fap)), titanium dioxide and reduced concentrations of the hydrogen peroxide sensitive in the visible light to achieve whitening synergetic bleaching effect with simultaneous remineralization of teeth.

TiO_2 was sensibilized in the visible light using doping with S and C. The reactivity of the compositions under blue (460nm) and green radiation (525nm) LEDs was measured by method of electron magnetic resonance. The ESR spectra under blue light and green light irradiations for $Ti0_2$, $Ti0_2$:S,C and FAP-$Ti0_2$:S,C / HAP-$Ti0_2$:S,C samples with limited presence of H_2O_2 were obtained. EPR spectra of all samples nanopowders were investigated at room temperature using the EPR spectrometer. All samples were researched in the dark and under blue light radiation and green light radiation LEDs with illumination 0.01 W/cm^2. The characteristic DMPO-OH spin adduct after irradiation of $Ti0_2$ and FAp-$Ti0_2$, was obtained. The spin adduct indicated that HO• was generated through excitation of Ti02:S,C under blue light irradiation. The spin adduct of superoxide generated from samples HAp during green light irradiation was observed. Our study using EPR spectroscopy and spin trapping has shown that HO• generation through excitation of FAp-$Ti0_2$ is greater than that of HAp-Ti02. It means, that the composition based on $Ti0_2$ doped with S, nanoFAp at limitation of 6% hydrogen peroxide can be used for photocatalytic processes initiated bleaching- remineralization using LED visible radiation spectrum, including the light source for polymerization, which is available in every dentists office.