ABSTRACT

Ferrimagnetic bioactive glass ceramics are expected to be potential candidates for the hyperthermia treatment of cancer. When placed in an alternating magnetic field of high frequency, these materials generate heat energy by hysteresis and eddy current losses. Tumor cells usually perish around 43 °C due to the poorly developed nervous and circulatory system whereas healthy body cells remain unaffected at this temperature. Such materials should have the adequate ability to bond with the tissues (bioactivity). Much work has been done on Fe_3O_4 containing glass ceramics for this purpose but present work is the first ever detailed study of its kind on $ZnFe_2O_4$ containing ferrimagnetic bioactive glass ceramics for the hyperthermia treatment of cancer.

Glass ceramics of the composition (%wt) $xZnO \bullet 25Fe_2O_3 \bullet (40 - x)SiO_2 \bullet 25CaO \bullet 7P_2O_5 \bullet 3Na_2O$ were prepared by melt-quench method and subsequent sintering at 1100 °C. After sintering the materials were quenched to about -10 °C to cause ferrimagnetism by preserving the high temperature state of mixed spinels, i.e., random distribution of cations at tetrahedral (A) and octahedral (B) sites of the spinel lattice. Magnetic properties of ferrimagnetic materials were further enhanced by cooling the materials in an aligning magnetic field to cause anisotropy. XRD was used to study the crystalline phases in the materials. Magnetic properties of the materials were studied using VSM. The sample X10 (having 10% ZnO) exhibited the highest hysteresis area. Calorimetric properties were studied by placing the materials in a magnetic induction furnace. The sample X10 exhibited the best magnetic heat generation due to its highest hysteresis losses. Anisotropic materials showed better magnetic and calorimetric properties than the non-aligned materials.

Materials were immersed in simulated body fluid (SBF) for 3 weeks to study the bioactivity. *In Vitro* characterization was carried out using XRD, FTIR, SEM, EDS, AAS & pH meter. The results confirmed that all samples were bioactive as layers of biological hydroxycarbonate apatite (HCA) appeared after 3 weeks. Sample X10 exhibited adequate bioactivity. Due to balanced calorimetric & biological properties, sample X10 was considered the potential material of choice to be used for the hyperthermia treatment of cancer as well as for re-enforcement of the damaged bones.