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ENHANCED OSL EMISSION FROM α-Al_2O_3 PRODUCED IN PRESENCE OF HALLOYSITE NANOCRYSTALS

FERREIRA, C.B.B.M, and GUIDELLI, E.J.

Departmento de Física Médica, FFCLRP, Universidade de São Paulo, 14040-901 Ribeirao Preto, SP, Brazil

Introduction: Aluminium oxide is widely used in the dosimetry of ionizing radiation, although commercially restricted due to the high cost and difficult synthesis. The anion defective α-Al_2O_3:C have some properties such as high sensitivity, reproducibility and low residual signal. The main objeticve of this study was the development of a seed-mediated synthesis of α-Al_2O_3 using halloysite nanocrystals as seeds, and the analysis of the dosimetric characteristics of the produced samples.

Material and method: In the present study, the aluminium oxide was produced through the combustion method. To this end, aluminium nitrate (10 g), urea (2 g) and halloysite (0 mg, 125 mg, 250 mg, 500 mg and 750 mg), were mixed and dissolved in 10 ml of MilliQ water. The solution was transferred to a cylindrical alumina crucible and introduced into a muffle furnance at 500°C for 5 min. The obtained powder was ground and calcinated at 1200°C for 12 h.

The samples were irradiated with 10 Gy using an X-ray tube (Magnum, Moxtec Inc.) operating with 48 kVp and 0.2 mA. The OSL curves were collected upon blue stimulation (470 nm) and using Hoya U340 filters (transmission between 270 nm and 370 nm), with the continuous reading mode (CW-OSL).

Results: The table 1 below shows the OSL results in term of the integrated area:

Table 1: OSL intensities for 20 mg samples receiving a dose of 10Gy

Calcined halloysite					
Area 1	Area 2	Area 3	Area 4	Mean	σ
4.815E+4	4.070E+4	3.460E+4	4.370E+4	4.180E+4	5685.700
Uncalcined halloysite					
Area 1	Area 2	Area 3	Area 4	Mean	σ
1.310E+4	1.290E+4	1.380E+4	1.210E+4	1.300E+4	699.400
Samples with 250 mg of halloysite					
Area 1	Area 2	Area 3	Area 4	Mean	σ
1.290E+5	1.540E+5	1.200E+5	1.510E+5	1.380E+5	87.170
Samples without halloysite					
Area 1	Area 2	Area 3	Area 4	Mean	σ
1.770E+4	1.920E+4	2.030E+4	2.370E+4	2.020E+4	2534.720

The OSL investigations reveaed enhanced OSL intensity for samples of Al_2O_3 produced in presence of halloysite, with maximum enhancement (7-fold) for samples synthesized with 2.5% mass percentage of halloysite (respective to the mass of aluminium nitrate). Results also revead that the OSL intensity from pure halloysite, either calcine or non-calcined, are much lower than the OSL intensity of the composites, indicating that the enhanced OSL is not caused by the OSL emitted by the halloysite nanocrystals. Therefore, this result implies that halloysite could act as the crystallization seedsthereby promoting a heterogenous nucleation process of the aluminium oxide.

Conclusions: The highest OSL signal was obtained for samples with 250 mg of halloysite. Moreover, the calcined halloysite does not show a comparable signal such as the aluminium oxide sample produced with halloysite. Finally, the halloysite acts as a seed to provide surfaces for crystal growth.

References:

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