Purpose: To use the Monte Carlo code PENELOPE to study attenuation and tissue equivalence properties of α-Al2O3:C for OSL dosimetry. Methods: Mass attenuation coefficients of α-Al2O3 and α-Al2O3:C with carbon percent weight concentrations from 1% to 150% were simulated with PENELOPE Monte Carlo code and compared to mass attenuation coefficients from soft tissue for photon beams ranging from 50kV to 10MV. Also, the attenuation of primary photon beams of 6MV and 10MV and the generation of secondary electrons by α-Al2O3:C dosimeters positioned on the entrance surface of a water phantom were studied. Results: A difference of up to 90% was found in the mass attenuation coefficient between the pure α-Al2O3 and the material with 150% weight concentration of dopant at 1.5 keV, corresponding to the K-edge photoelectric absorption of aluminum. However for energies above 80 keV the concentration of carbon does not affect the mass attenuation coefficient and the material presents tissue equivalence for the beams studied. The ratio between the mass attenuation coefficients for α-Al2O3:C and for soft tissue are less than unit due to the higher density of the α-Al2O3 (2.12 g/cm³) and its tissue equivalence diminishes to lower concentrations of carbon and for lower energies due to the relation of the radiation interaction effects with atomic number. The larger attenuation of the primary photon beams by the dosimeter was 16% at 250 keV and the maximum increase in secondary electrons fluence to the entrance surface of the phantom was found as 91% at 2MeV. Conclusions: The use of the OSL dosimeters in radiation therapy can be optimized by use of PENELOPE Monte Carlo simulation to provide a study of the attenuation and response characteristics of the material.