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Hardness and elastic modulus of castor oil polyurethanes after gamma irradiation

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Abstract – Polyurethanes from castor oil are being employed as bone cement in medical applications. In this work the mechanical properties of gamma irradiated polyurethanes derivate from castor oil were investigated by instrumented indentation. A slightly increase in hardness is observed only for doses as high as 100 kGy.

Polymers derivate from biomass are a natural tendency nowadays as non polluting substitutes. Polyurethanes are versatile polymers due to their large spectra of properties. In some applications the polymers are irradiated by gamma radiation to sterilize them. Gamma radiation can cause chain scission [1] or crosslink [2]. Polyurethanes from castor oil are being employed in medical applications as bone cement [3].

In this work the polyurethane C.O.R. (Ricinus bone composite) (Poliquil), not previously sterilized, was investigated. The samples were irradiated with gamma radiation in doses 1 kGy using a Theratron 780 at Hospital Erasto Gaetner, with activity of 5 Gy/min. High doses of 25 kGy and 100 kGy were applied in equipment employed for sterilization for medical applications. Mechanical properties of irradiated surfaces were measured by instrumented indentation. Hardness and elastic modulus were determined from standard load versus displacements curves generated by a Nanoindenter XP with a Berkovich indenter [4]. The unloading rates were high enough to avoid the time dependent effects in hardness measurements by instrumented indentation due to viscoelastic properties of the polymer.

The crosslinking and/or chain scission induced by radiation effects can alter the chemical bonds at surface region causing modifications in the hardness and elastic modulus. The polyurethane C.O.R. have a slightly increase in hardness indicating that the crosslinking process at surface is more pronounced than the chain scission. The elastic modulus does not show significant modifications since this property is related to long distance effects, since the contribution for elastic response came from larger regions than that for plastic deformation, which is the main contribution for hardness values.

The mechanical stability of C.O.R. to gamma irradiation indicates that this material does not suffer significant mechanical changes under gamma irradiation until doses of 100 kGy.

References

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