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MECHANICAL CHARACTERIZATION OF POLYMERIC MICROSPHERES THROUGH MICRO-COMPRESSION TESTING

Gianpaolo Serino¹, Valentina Crognaleti², Costantino Del Gaudio², Umberto Morbiducci¹, Alberto L. Audenino¹
1 Department of Mechanical and Aerospace Engineering, Politecnico di Torino, Turin, Italy
2 Department of Enterprise Engineering, University of Rome “Tor Vergata”

Introduction
Usage of polymeric microspheres in biomedical applications is dramatically increasing in the last years. In this study the mechanical properties of a new design of polymeric microspheres to be used as carriers for local release of drugs and grow factors, are investigated. Technically, nanoindentation is applied on microspheres of size in the range 30-70 µm. To measured load-displacement data, the Hertz model is applied to estimate the Young’s modulus.

Materials and Methods
The water-in-oil emulsion method was applied to gelatin type A to produce three types of microspheres characterized by a different percentage of genipin. Genipin in three different values of concentration (w/v) %. 0.1% (group 1), 0.5% (group 2), and 1% (group 3), was used as natural cross-linker.

The Nanoindenter XP (Agilent/MTS company) was adopted and a specific protocol was developed.

The explanatory results displayed in Figure 5 are representative of all the nanoindentation tests performed on single microspheres and indicate that there is a satisfactory agreement between the Hertz model for contact and the experimental data.

The percentage of genipin influences the mechanical properties of the microspheres. The analysis of variance (ANOVA) applied to the tests carried out on microspheres shows a correlation (p<0.05) between their mechanical properties and the percentage of genipin used during the production of the microspheres. The progressive increase in the percentage of genipin in microspheres composition is not related to a linear increase of the Young’s modulus. Furthermore the analysis shows that there is not statistical difference between microspheres of group 1 and 2.

Conclusion
1. The average values of the standard error (and of Rp) with respect to the load-displacement curves estimated by applying the Hertz contact model are equal to 1.55 mN (Rp=0.98), 1.59 mN (Rp=0.99), and 2.10 mN (Rp=0.99), for group 1 group 2 and group 3, respectively. These data confirm that the selected Hertz model satisfactorily fits the experimental data as obtained from the application of a nanoindentation strategy, making the estimated mechanical properties reliable.
2. The value of Young’s modulus for microspheres belonging to group 2 is lower than group 1, so an increasing of genipin of only the 0.4% (w/v) is not able to improve the mechanical characteristics of microspheres.
Several limitations could weaken the findings of this study. In particular, the defined deformation at 5% of the initial radius, which limits the validity of these results only for small deformation. Moreover, nanoindentation tests were carried out in dry condition.

References