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CNT-POLYDIMETHYLSILOXANE NANOCOMPOSITES FOR PROSTHESIS INTERFACES

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Summary: Amputation causes profound changes in individual's health, affecting their perception of comfort and quality of life. The rehabilitation process involves, in most cases, a successful prosthetization. The prosthesis must fulfil a series of conditions such as comfort, easy placement, weightlessness, durability, good mechanical function, pleasing aesthetics, easy maintenance, and low cost. Its proper application is directly dependent on the correct selection of materials, according to their structure, properties and behaviour.

Of all the components of the prosthesis, the interface (or liner) has particular importance, due to its function in establishing a direct connection between the stump and the prosthesis, being responsible for the transmission of ground reaction forces, damping gait loads and tissue protection. Materials like silicone, silicone gel and urethane elastomers have been used in its confection. The inadequacy of the interface may result in serious problems, such as ulcers, contact dermatitis, eczema, epidermoid cysts and fungal infections or bacterial infections, mainly due to heating/sweating and pistoning.

Carbon nanotubes (CNTs) have generated great interest due to their optical, mechanical and electrical properties. They are flexible fiber-like materials with a high mechanical strength. They also behave as excellent electrical and thermal conductors and are chemically stable. They have already been proposed for biomedical applications, such as reinforced scaffolds, substrates for cell growth/differentiation and vehicles for the controlled drug delivery. However, to best of our knowledge, they have never been used in prosthesis liners.

The combination of CNTs with a correct elastomeric matrix can be of great value for the improvement of the mechanical and thermal properties of the interface material for tibial prosthetics. In this work, this approach is investigated. Polydimethylsiloxane (PDMS) will be used as elastomeric matrix, which is a polymer widely used in biomedical applications, such as adhesives, catheters, drains or breast implants. PDMS shows a combination of unique properties, being highly flexible at low and high temperatures and exhibiting excellent biocompatibility.

The aim of this work is to develop a new alternative material to prosthesis liners, based on CNT-polydimethylsiloxane nanocomposites, which should be biocompatible and lead to an improved thermal and mechanical behavior of the interface, in order to better accommodate the tissues, distribute the load, reduce the impact on the stump and increase the comfort and quality of life of the amputees.

The first tests showed that a good dispersion of the CNTs in the PDMS matrix was achieved, producing uniform nanocomposite with aligned CNTs. It was also possible to verify the composite stability and an increase of the thermal conductivity. The dynamic-mechanical behavior of the new CNT-reinforced liners was assessed and compared with that of commercial liners.