Study of the Formation of Self- Assembled Monolayers on Nitinol

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Statement of Purpose: For the first time self-assembled monolayers (SAMs) were formed and characterized on the native oxide surface of nitinol. Factors which can affect the formation of SAMs such as head group functionality, chain length, tail group, deposition method, and surface content were varied and analyzed to form the most stable and strongly adhered monolayer on the surface. Since an alloy is being studied, the formation of SAMs was studied on nickel and titanium oxide, the components of the nitinol surface. In the long term, the formation of strongly adhered self-assembled monolayers may form an effective interface between the biomaterial, nitinol, and the human body.

Methods: Oxide substrates were sanded and cut into 1 x 1 cm squares. The substrates were cleaned by solvent rinsing and sonication. The organic acid solutions were prepared using dry THF. SAMs were prepared from solution. Diffuse reflectance infrared spectroscopy (DRIFT), contact angle, atomic force microscopy (AFM) and MALDI-TOF MS were used to characterize the surface before and after organic modification.

Results / Discussion: Self-assembled monolayers were formed on the nickel oxide, titanium oxide, and nitinol oxide surfaces using organic acids. Self-assembled monolayers were formed on nickel, and nitinol surfaces using three organic acids: carboxylic, hydroxamic and phosphonic acids. Formation of monolayers was consistent with the observation that stronger acids form SAMs more readily because phosphonic acid formed more strongly adhered monolayers on the nickel, titanium or nitinol oxide than carboxylic or hydroxamic acid. SAMs presenting a variety of tails groups, including methyl, hydroxyl, amino, bromo, phosphonic and carboxylic acid were formed. Contact angle data was consistent with the formation of complete hydrophilic (ie, hydroxyl, amino, phosphonic, carboxylic acid) and hydrophobic monolayers. MALDI-TOF MS is utilized as a method to characterize chemical species monolayers on metal oxide surfaces.

Conclusions: Self-Assembled Monolayers were formed on nickel oxide, titanium oxide and nitinol. DRIFT and MALDI-TOF MS analysis confirmed the formation of the SAMs on the surfaces. Phosphonic acid adhered more strongly to the three surfaces than carboxylic or hydroxamic acid. Additionally, phosphonic acid adhered to all three surfaces, while carboxylic and hydroxamic acid only adhered to nickel and nitinol oxide surfaces. This is the first report of monolayers on the oxide surface of nickel or nitinol, without prior reduction to the metals surface.

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