Andrea Spaggiari

Eugenio Dragoni

University of Modena and Reggio Emilia, Italy

Nickel-Titanium shape memory alloys: Design and development of biomedical devices

Nickel-Titanium shape memory alloys (SMAs) are a smart material with peculiar properties, which are widely exploited in the biomedical field. These materials exhibit two very interesting behavior, the shape memory effect and pseudo-elastic effect, which could be thermally or mechanically triggered. SMAs could undergo very large deformation, even more than 10% and yet recovering the initial shape when the load is removed. They can be deformed and recover the initial shape upon a thermal activation, or they are able to provide a constant force for a given displacement. Their intrinsic hysteretic behavior, along with a quite low elastic modulus, are two elements that makes SMA quite interesting in the prosthetic devices. The excellent corrosion properties, the mechanical strength, the biological and magnetic resonance compatibility, explain the large use of SMA devices in the biomedical field, in particular for mini-invasive techniques. These extraordinary capabilities are due to the microstructural properties of the alloys, which present two stable phases, austenite or martensite, according to the thermomechanical condition applied. Many biomedical devices based on the NiTi SMA are nowadays already on the market in dental, orthopedics, vascular, neurological, and surgical field. However, the smart exploitation of these materials could lead to these results even though these materials presents a high complexity in the design problem, only thanks to a very close collaboration between material scientist, clinicians, engineers and designer. This concurrent engineering approach is needed to overcome several drawbacks such as the thermomechanical fatigue, the temperature sensitivity in order to increase the repeatability of the results. The correct thermomechanical design could be a first step in the exploitation of this very interesting class of materials.

Speaker Biography

Andrea Spaggiari is a 36 years old mechatronics engineer. From 2011 he works as assistant professor at the University of Modena and Reggio Emilia and he is the lecturer of the academic course of “New Materials for Mechatronics Constructions” and of “Integrated 3D Modelling for Mechatronic design” in the master in mechatronic engineering. His current research interests are threefold. First, studying the properties and the mechanical behavior of structural adhesives and their efficient modelling. Second, working on smart materials applications, especially with magneto-rheological fluids and shape memory alloys and his third research covers the multiscale computational simulations of voids and defects in polymeric materials. The research activities led to several industrial projects and to more than 50 papers in international journals.

e: andrea.spaggiari@unimore.it

Notes: