

Comparative Study of NiTi Orthodontic Wires

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Introduction

Superelastic nickel-titanium orthodontic wires enable the creation, transmission and control of light and continuous forces that allow tooth movement, which leads to the correction of tooth position. Despite characteristics like high yield strength, low elastic modulus and high resilience, the clinical interest of these wires lies in their superelastic behavior. In this study, the determination of phase transformation temperatures along with the identification of predominant phase at room and intraoral temperatures were accomplished throughout DSC analysis; superelastic behavior were analyzed through tensile tests. Due to intraoral conditions and specificity of orthodontic fixed appliances, a new approach is presented for the 3-point bending tests which included brackets in their settings in order to compare orthodontic wires performances. Wire slippage inside the brackets and friction due to wire-bracket-ligature combinations on bending and pulling tests, respectively, are also discussed.

Materials and Methods

Material

Superelastic Ni-Ti orthodontic wires from two commercial brands, Dentaureum and Ormco, with a 0.46 x 0.64 mm² rectangular cross-section.

Tests

DSC thermal analysis (DSC 204 F1 Phoenix model from Netzsch)

Heating and cooling rate of 10°C/min.

Tensile testing (Shimadzu AG 50kN)

Gauge length 26 mm; stroke speed: 3mm/min; maximum strain 8%.

Orthodontic fixed appliance



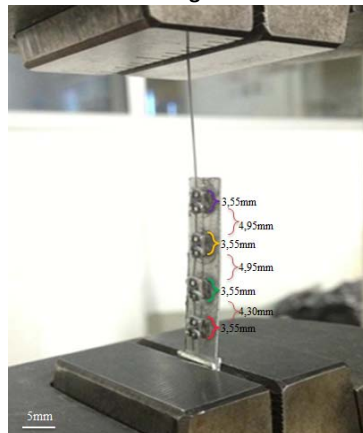
During orthodontic treatment, the wire is placed along the brackets. Wire-bracket connection is made through elastomeric ligature.

Modified 3-point bending test



Mounting consists in 2 sets of aluminum plates placed 6.40mm apart; 1 row of 4 Dentaureum brackets was attached. Wire-bracket connection is made through Morelli elastomeric ligatures. Load is applied on a bracket positioned at the midpoint.

Pulling test

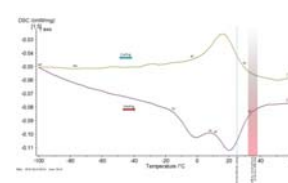


The wire, which is attached to the top grip, is pulled across 4 Morelli brackets glued to an aluminum plate attached to the bottom grip. Morelli and Dentaureum elastomeric ligatures were used.

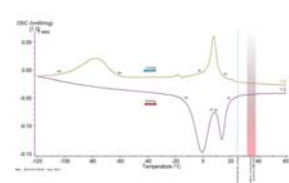
Results

DSC Analysis

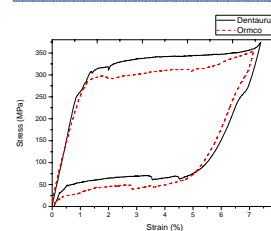
Dentaureum:



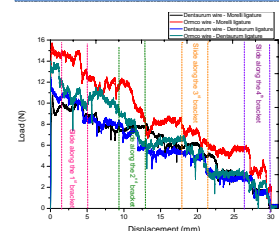
Ormco:



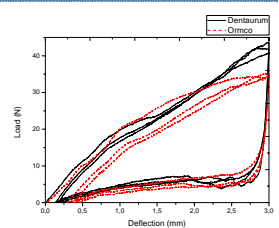
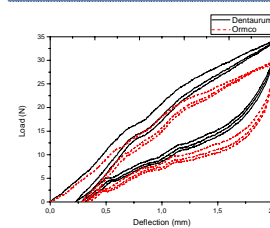
Tensile Tests



Pulling Tests



Modified 3-Point Bending Tests



Conclusions

DSC results showed that Dentaureum wire had, at room temperature, a predominance of austenitic phase with some residual R-phase, being fully austenitic at intraoral temperature, while Ormco wire revealed a fully austenitic phase at room and intraoral temperatures. Pulling tests exhibited force fluctuations due to the friction caused by wire-bracket-ligature connection. Both tensile and bending results showed a superelastic behavior; lower forces corresponding to Ormco wires' reverse phase transformation plateau when compared to Dentaureum were exhibited. 3mm deflection tests highlight the wire slippage phenomenon inside the brackets.

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