

## **Abstract:**

### **Investigation the tensile strength and bending strength of NiTi orthodontic wires during the electrochemical etching process**

**Introduction:** The main purpose of this study was to investigate the mechanical properties of Ni-Ti orthodontic wires after color change by electrochemical etching and anodizing method.

**Materials and methods:** In this research work, the color change of NiTi orthodontic wires, which were anodized by electrochemical etching method, was investigated in the tested groups including: wire, disc and unmodified rods of this alloy. Also, the physical properties, mechanical properties (tensile strength and bending strength), morphology, surface roughness and contact angle of each sample were investigated using spectrophotometer, universal test machine, scanning electron microscope, atomic force microscope and contact angle analysis system respectively.

**Results:** By applying a voltage from 10 to 100 volts during the electrochemical etching process for NiTi alloy anodization (such as orthodontic wire), various colors can be produced on its surface. Compared to unmodified NiTi alloy wires, anodized NiTi wires showed lower contact angle and higher roughness. With the increase of the surface roughness and also the images obtained from the FE-SEM field emission scanning electron microscope, it was observed that with the increase of the voltage, the surface roughness and of course the topography of the surface undergoes a change, which was also proved by the AFM atomic electron microscope test. Finally, the results of the CA contact angle test, along with the results of other analyzes, proved the effect of voltage increase on the surface roughness, which leads to an increase in the hydrophilicity of the NiTi alloy surface. The results showed no statistical difference exists between coated Ni-Ti wires and conventional uncoated wires regarding to tensile and bending strength.

**Conclusions:** Using the electrochemical etching process for anodizing samples in each of the research groups can change the color of NiTi alloys at different voltages in a fixed time. It was observed that the roughness, topography and also the hydrophilicity of the orthodontic wires produced after the electrochemical process in NiTi alloys increased. The load-displacement curve of all wires looked similar. The electrochemical etching and anodizing has no effect on the mechanical strength of the base wire ( $P < 0.05$ ).

**Keywords:** Nickel/titanium orthodontic wire, electrochemical etching, mechanical properties, tensile strength, bending strength, color change