

Development of orthodontic wires for metal allergy patient using titanium nitride plating

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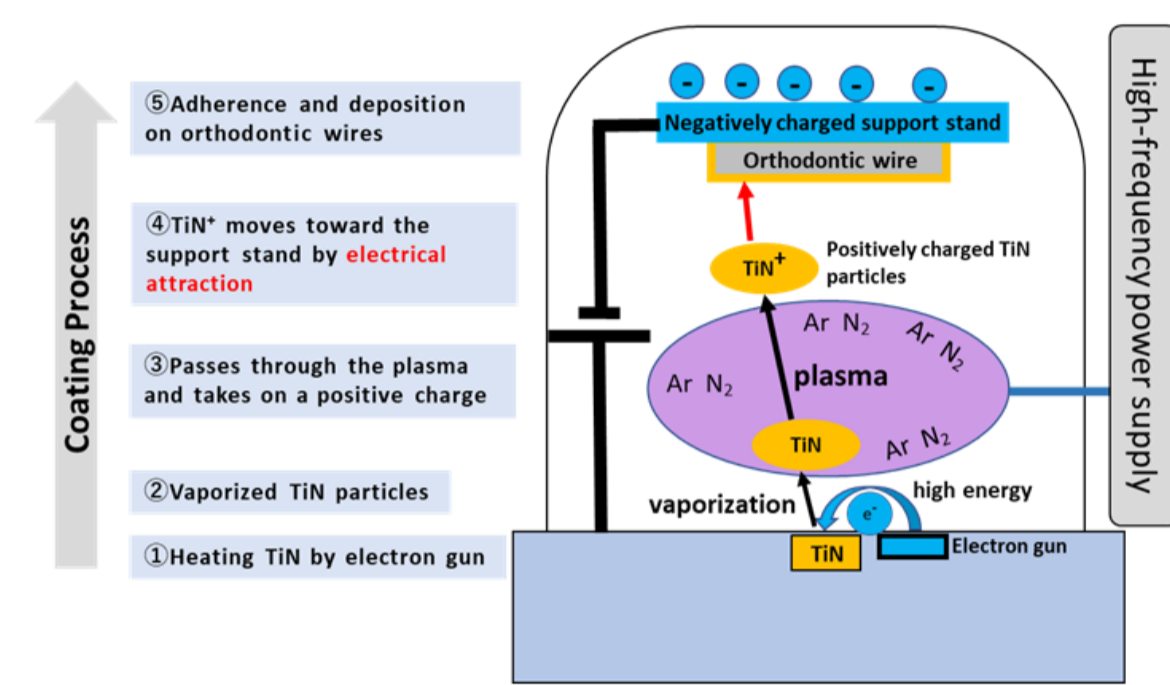


BACKGROUND and PURPOSE

Background

Four types of alloy wires, such as stainless steel (SS), cobalt-chrome (Co-Cr), nickel-titanium (Ni-Ti) and β -Ti, are clinically used as orthodontic archwires. Selective application of these alloy wires can provide broad range of orthodontic forces depending on various stages of treatment. The wires except for β -Ti contain metal elements such as Ni, Co and Cr, which release metal ions into the oral cavity, may cause metal allergies. Only β -Ti wire can be applied to the patients with metal allergies, which restricts wire selection and establishment of proper force system. To overcome this problem, modification of the surface of orthodontic wire except for β -Ti is necessary to prevent the release of metal ions.

TiN coatings process by PVD-type ion plating



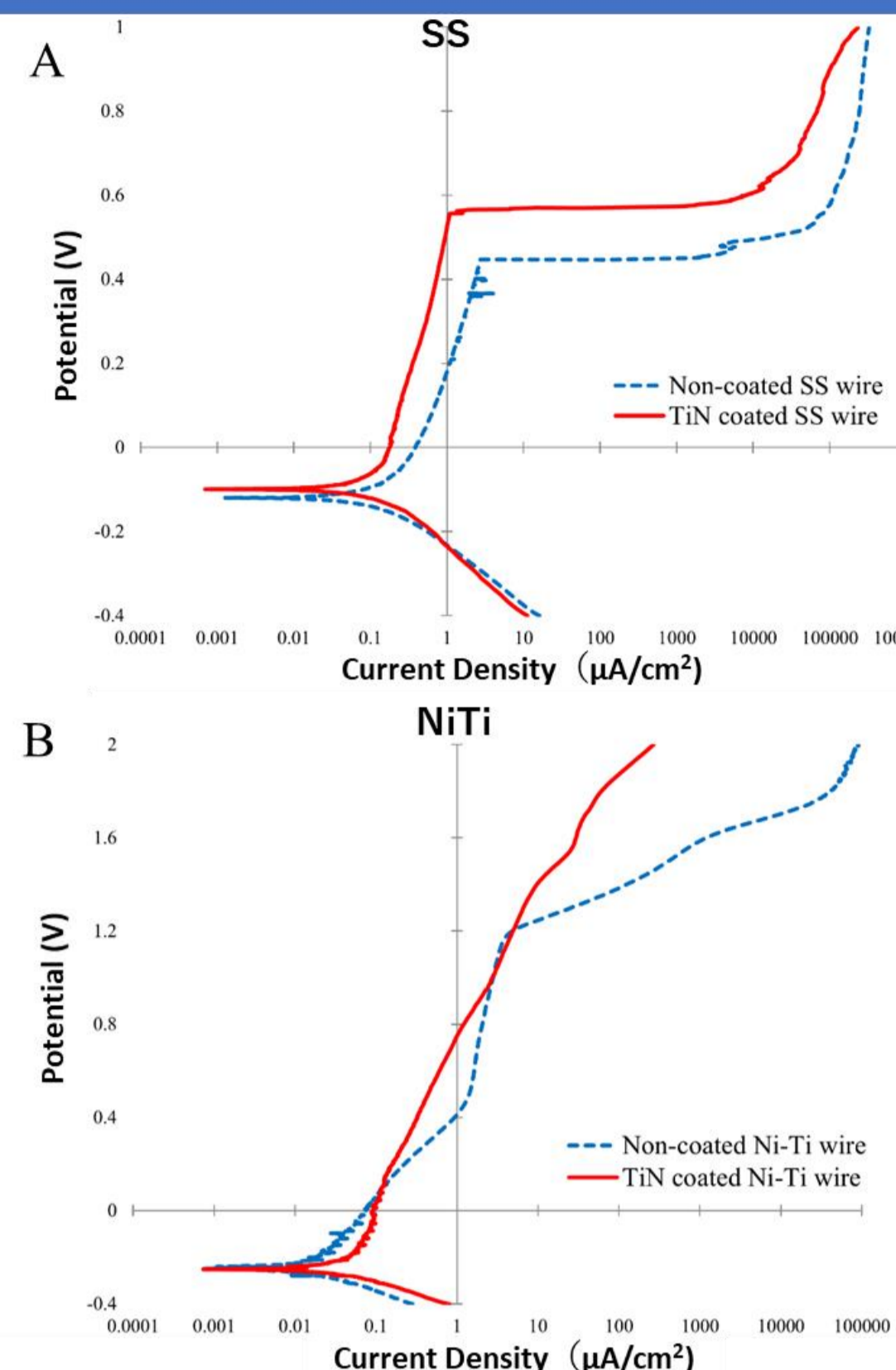
Advantages of TiN Coating

- Thin coating
- High corrosion resistance and biocompatibility
- Low temperature processing

Purpose

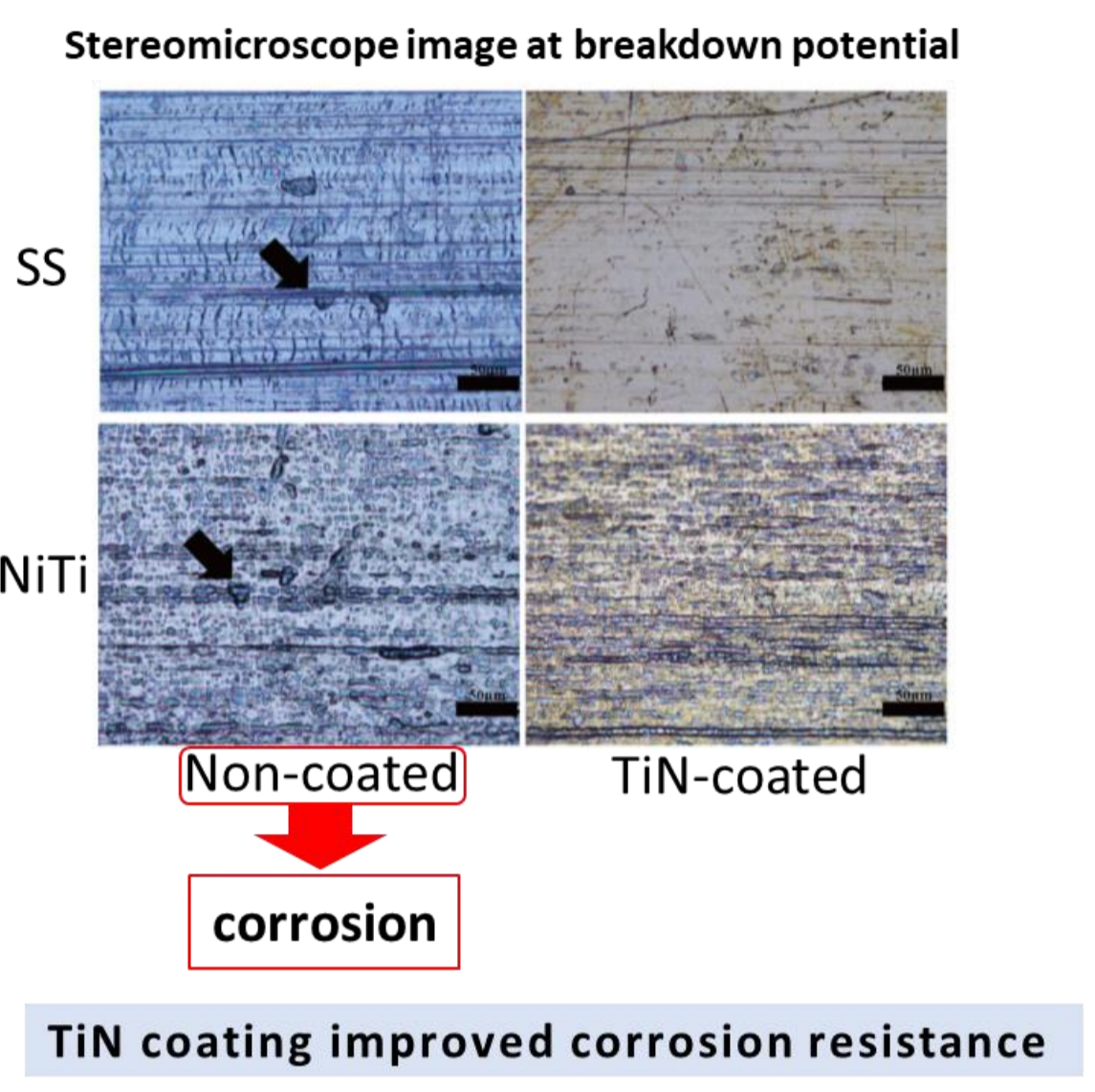
The purpose of this study was to examine effect of TiN plating of orthodontic SS and Ni-Ti wires on metal ion release and mechanical properties of the wires.

RESULTS electrochemical corrosion test



the breakdown potential was increased

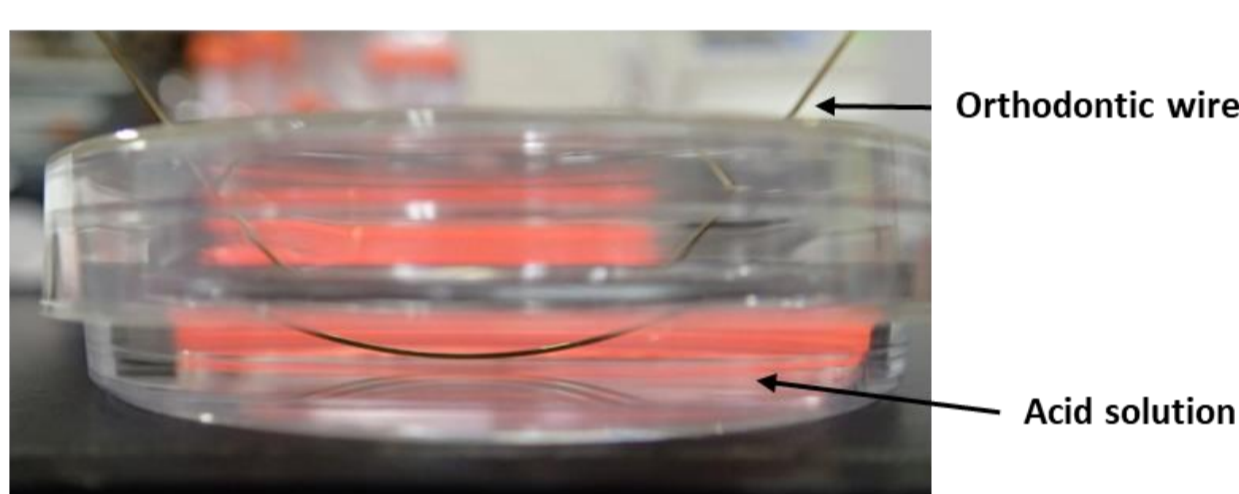
breakdown potential (V)	TiN coated	Non-coated
SS	0.61 ± 0.04 V	0.46 ± 0.05 V
NiTi	>2.0 V	1.20 ± 0.03 V



MATERIALS AND METHODS Metal ion release test

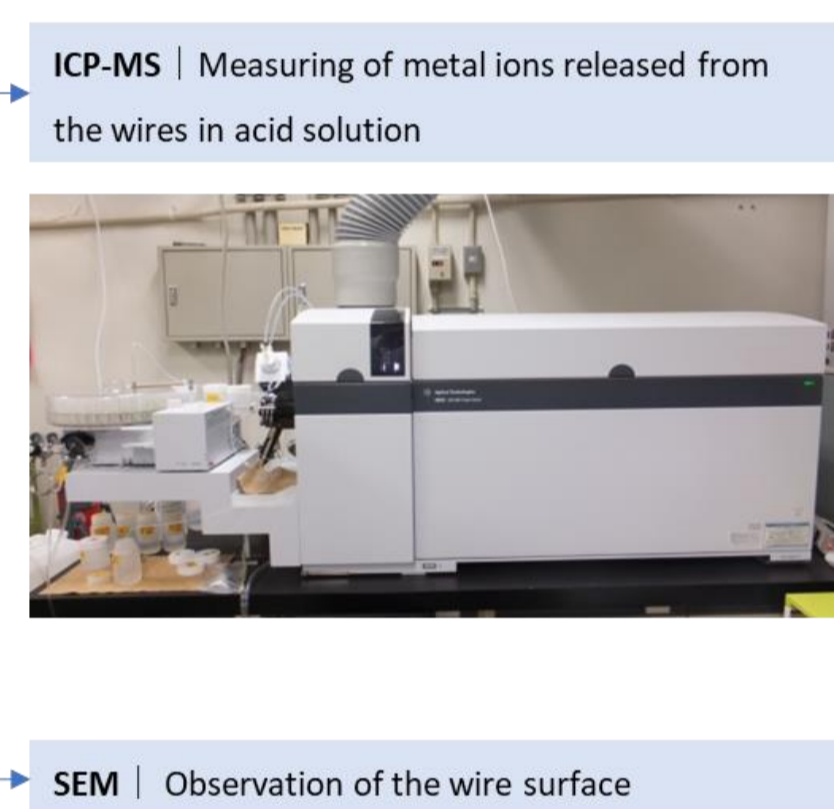
Metal ion release test

Orthodontic wires were partially immersed in acid solution. The concentration of metal ions eluted in the acid solution was measured and the wire surface roughness was observed.

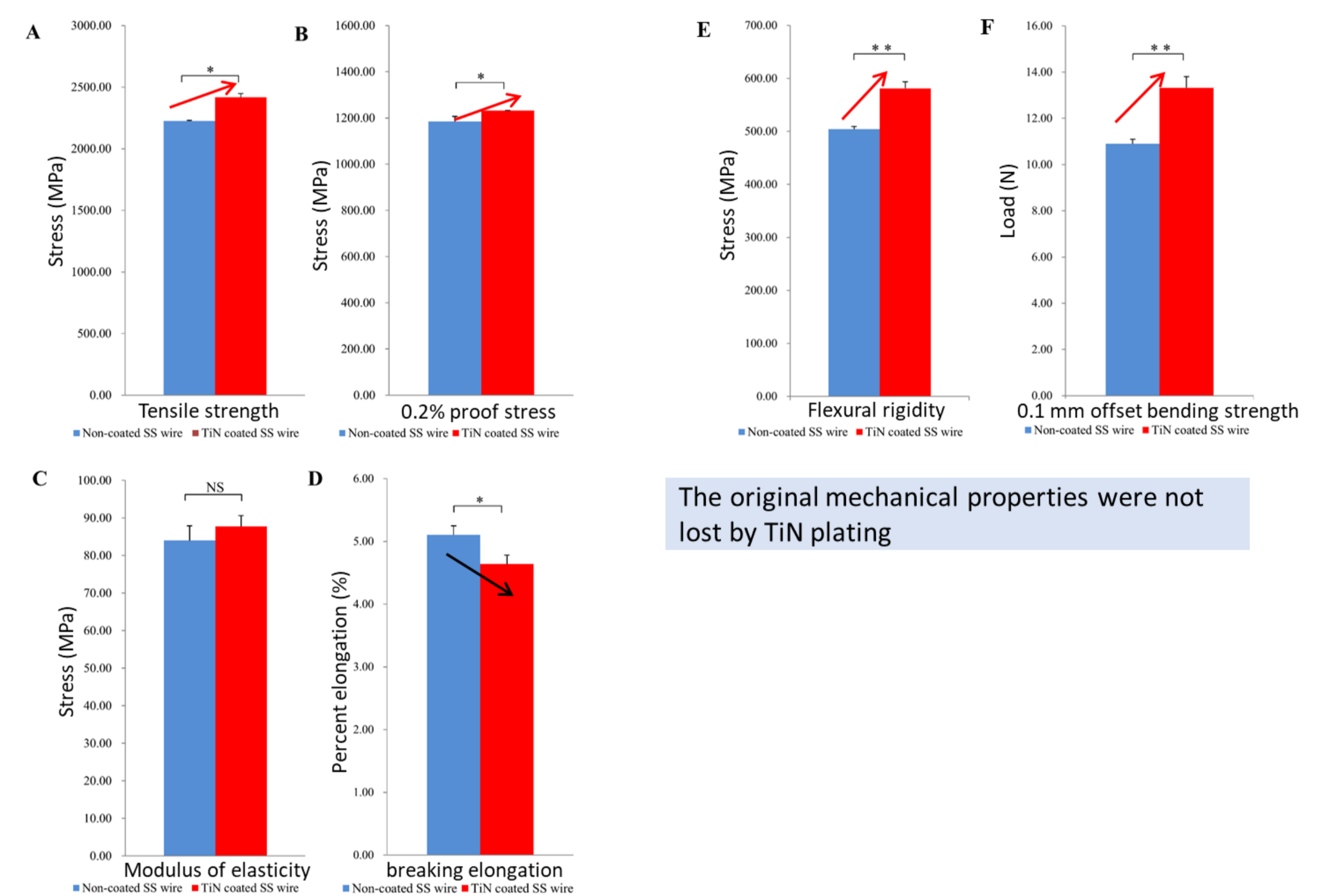


Experimental conditions

- Temperature | 37 °C / Incubation time | 30 min
- Acid solution
 - Hydrochloric acid or lactic acid (10ml)
- Orthodontic wire
 - Material | SS, NiTi (0.016 × 0.022-inch)
 - Coating thickness | 0.3µm
 - Length of immersion in acid solution | 25 mm

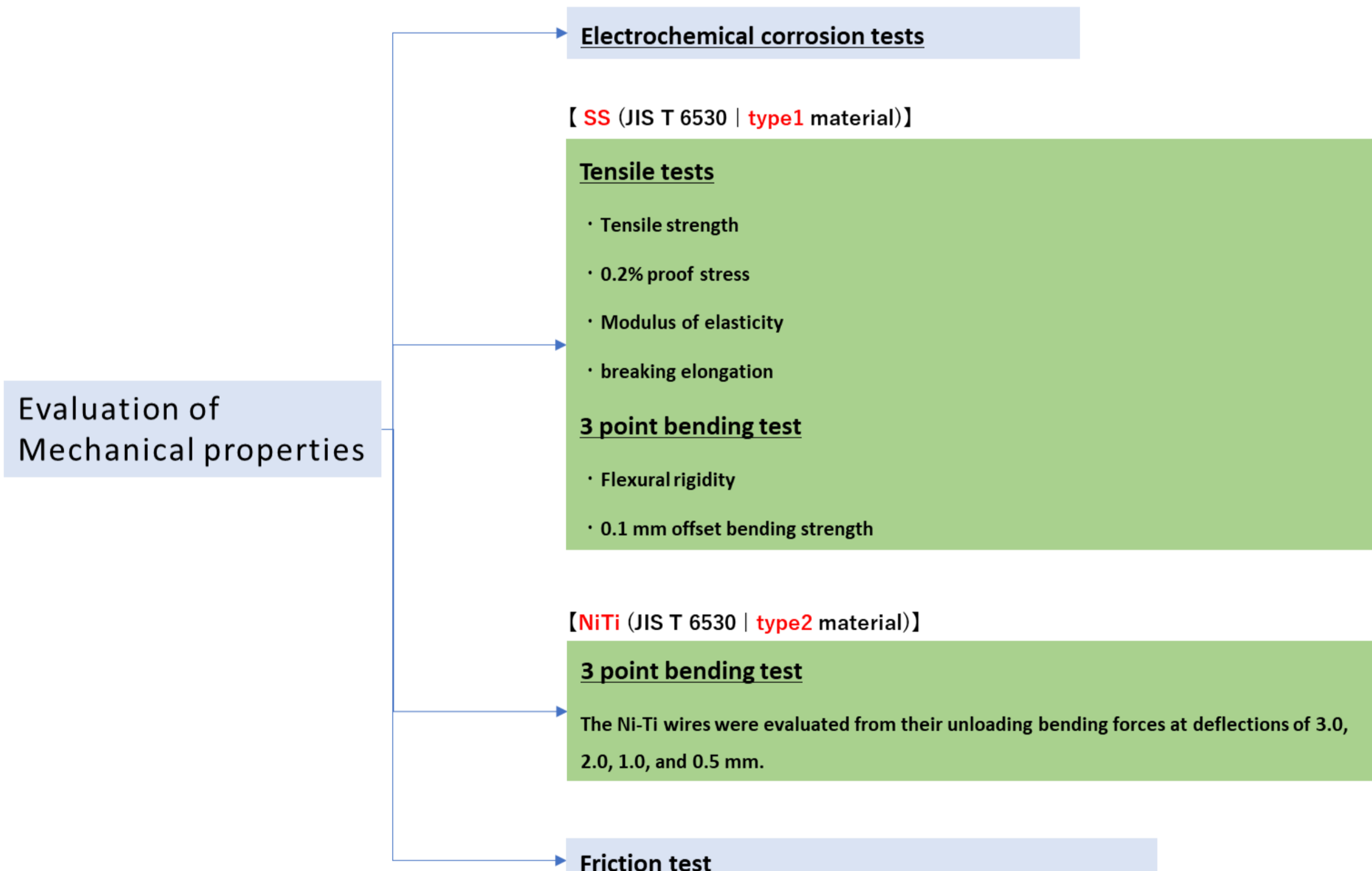


RESULTS Tensile tests and three-point bending test of SS wire

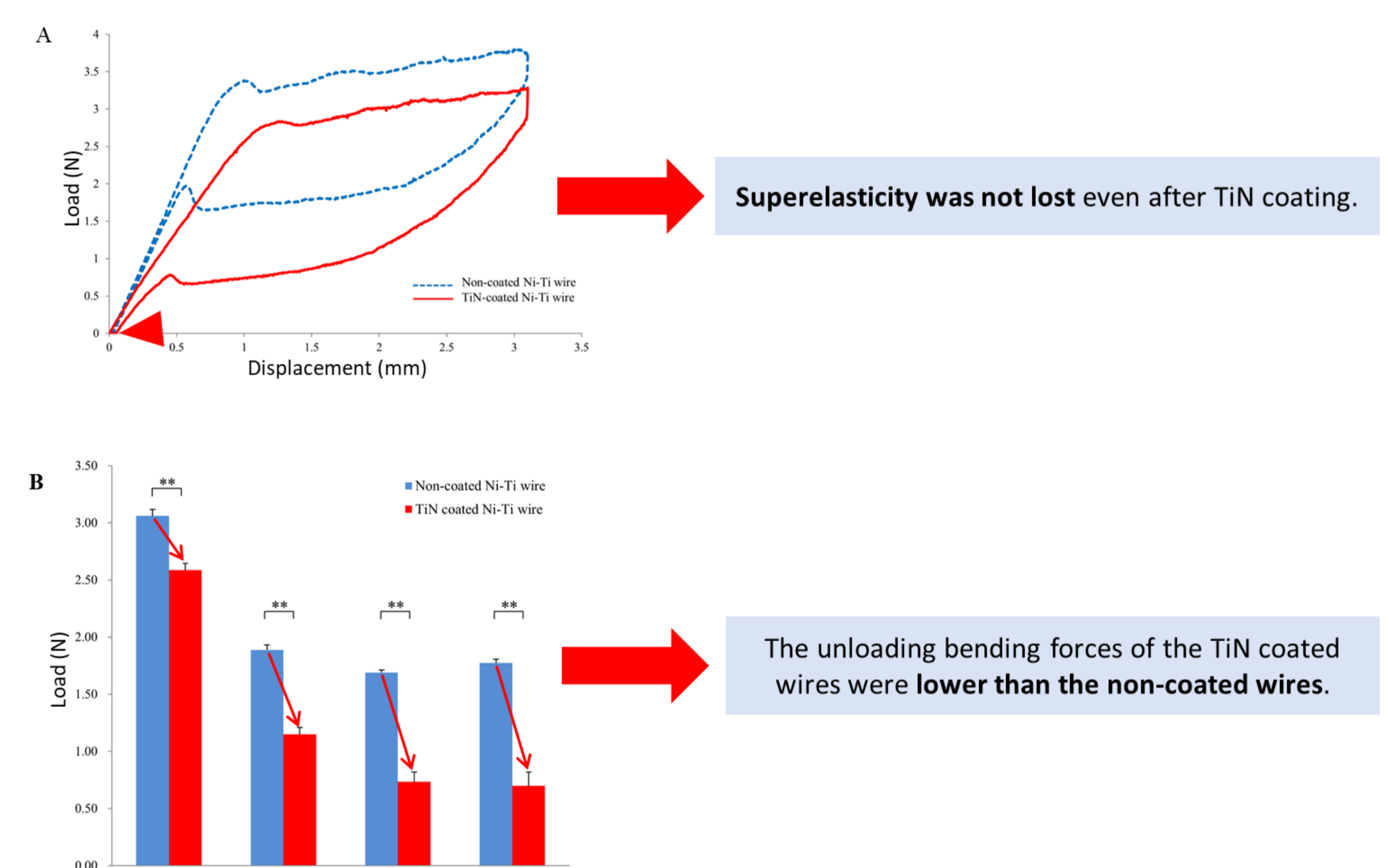


The original mechanical properties were not lost by TiN plating

MATERIALS AND METHODS Evaluation of mechanical properties



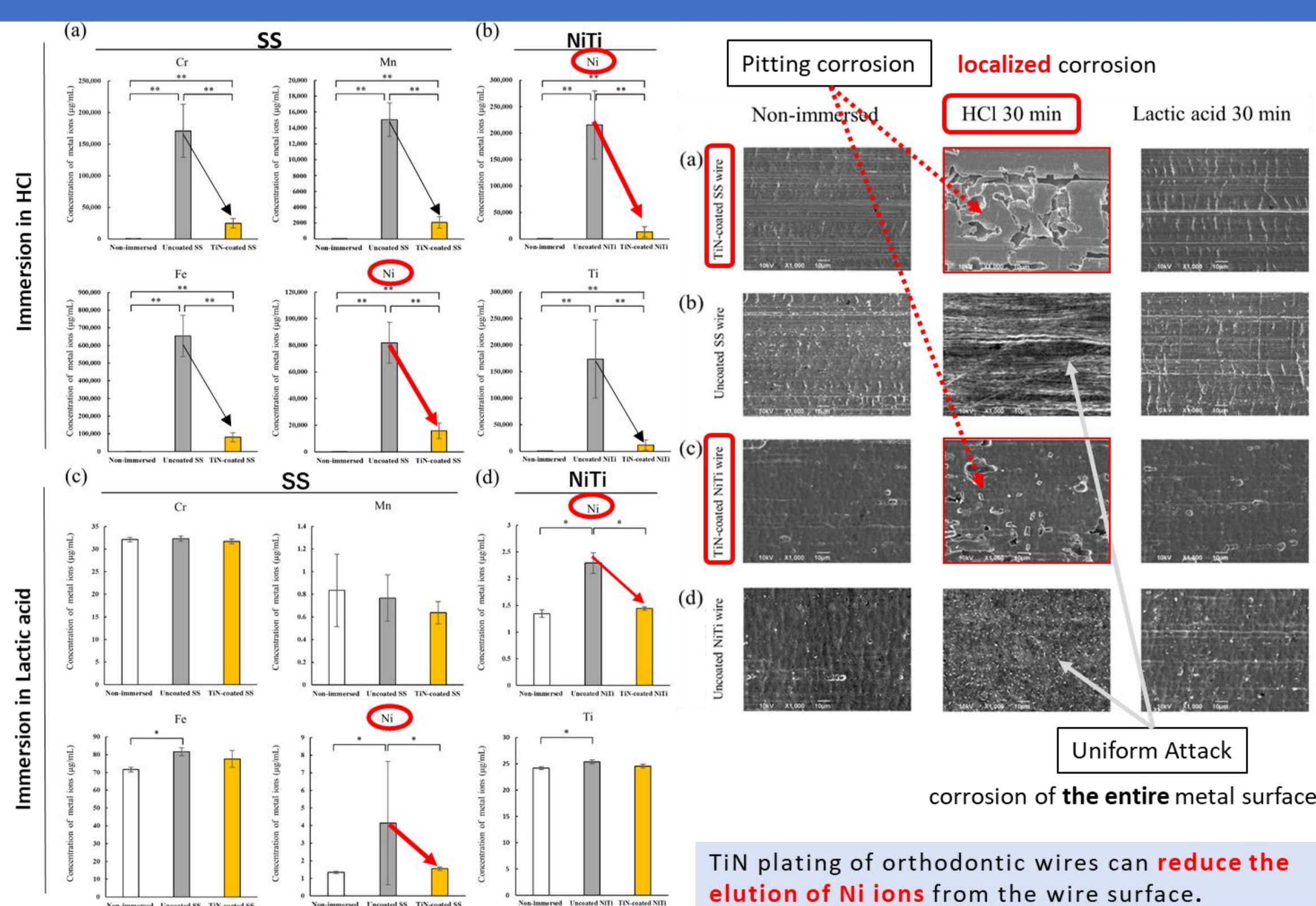
RESULTS Three-point bending test of NiTi



Superelasticity was not lost even after TiN coating.

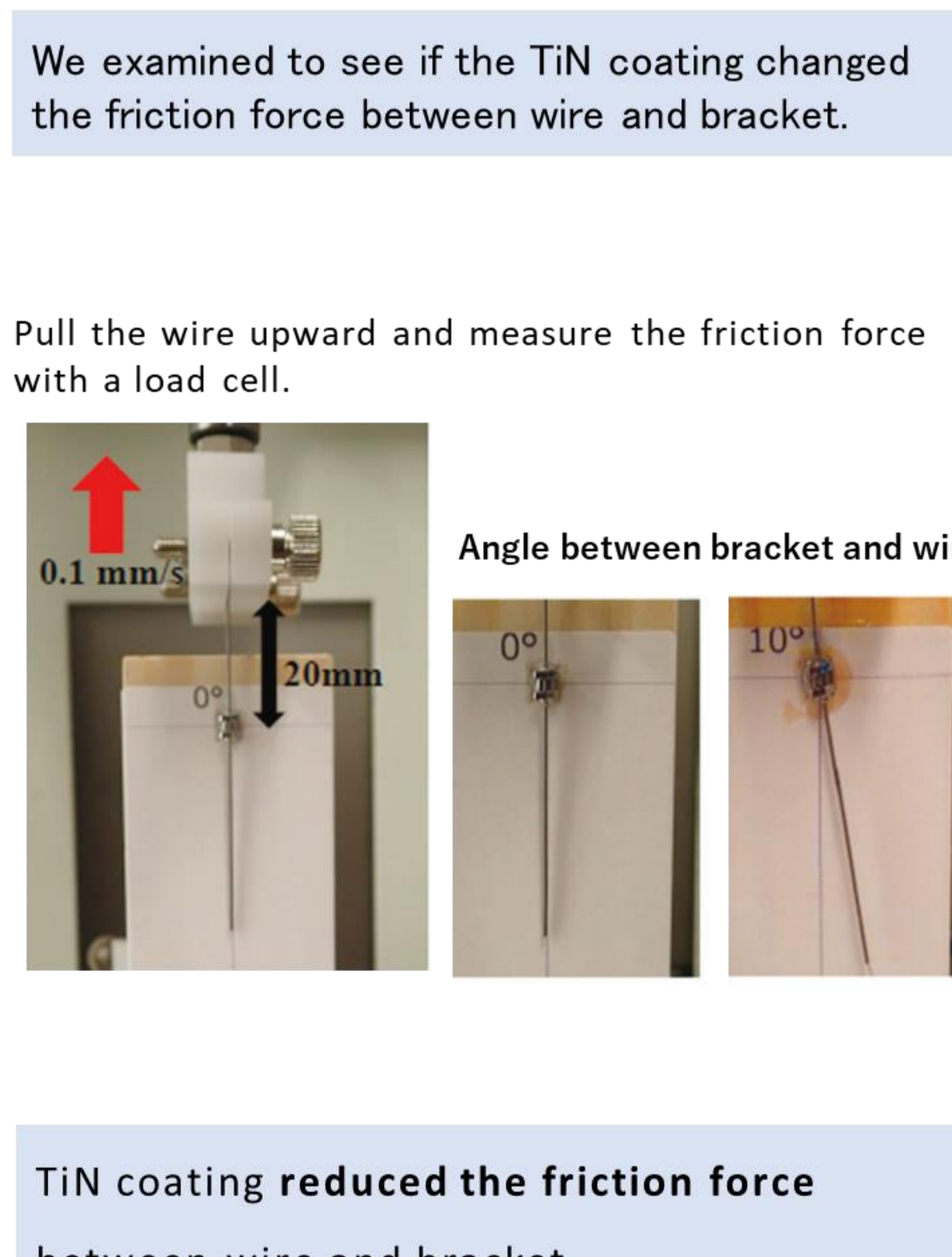
The unloading bending forces of the TiN coated wires were lower than the non-coated wires.

RESULTS Metal ion release test



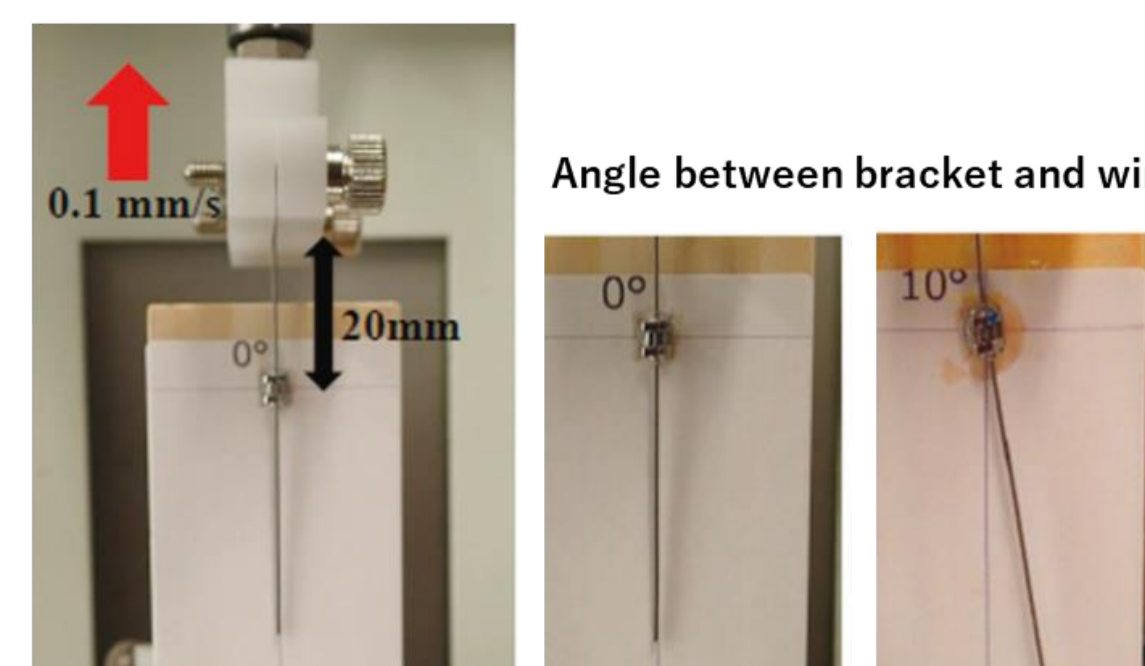
TiN plating of orthodontic wires can reduce the elution of Ni ions from the wire surface.

RESULTS Friction test



We examined to see if the TiN coating changed the friction force between wire and bracket.

Pull the wire upward and measure the friction force with a load cell.



TiN coating reduced the friction force between wire and bracket.

CONCLUSION

- TiN plating improved corrosion resistance, and showed low friction without compromising the original mechanical properties.
- These results suggest that TiN plating may be useful for metal allergic patients.