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Low-friction and safe coatings on suture needles via atmospheric pressure plasma polymerization

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With the objective of reducing the friction forces that are experienced during needle insertions, in our previous work [1], atmospheric pressure plasma-polymerized coatings based on different amino-silane liquid precursors were deposited on spinal needles. Decreasing these forces mitigates patients' pain, improves method accuracy and decreases bleeding and recovery times. Siloxane and amine molecules are necessary for achieving a low-friction behavior and avoiding the detachment of coatings after the injection test [1]. So, this study focuses on optimizing the low-friction capacity of plasma-polymerized coatings based on N1-(3-trimethoxysilylpropyl) diethylenetriamine (TRIAP) (the precursor that showed the best results in our previous work) on curved suture needles. The influence of plasma power, precursor gas flow and treatment time was analyzed. The evaluation of the penetration forces was carried out in accordance with the standard test method ASTM F3014-14. Coated and uncoated (control) suture needles were inserted 10 times into meat samples (as opposed to 4 insertions that were performed in the previous study). TRIAP-based coatings decreased friction forces around 30%, when compared with currently commercialized suture needles. This study also aims at the durability and toxicity of the coating; that is, ensuring that it remains stable during the puncture test, crucial for wound suture applications and to prevent lesions such as granulomas, rashes and reddening of the skin that occurs when silicone coatings are detached during needles punctures [2]. Toxicity was analyzed thought the identification of volatile compounds of the coatings by P&T-GC-MS essay. SEM and EDS analyses confirmed that the coating remained unchanged after 10 insertions. It has been noticed that the increase in punctures and the more complex curved geometry of the suture needles make it necessary to slightly increase the treatment times (compared to our previous work) to achieve a durable low-friction nature.

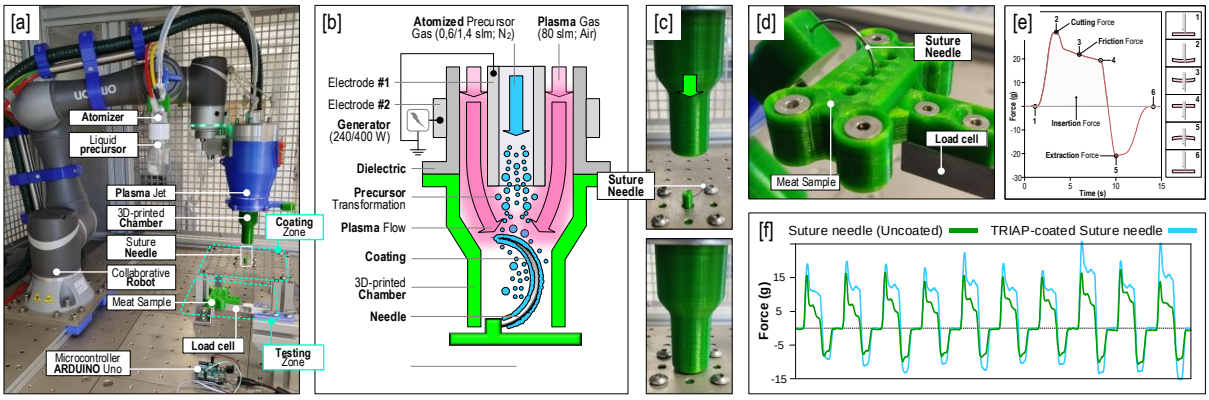

Fig. 1. [a] APPJ equipment, [b] plasma-polymerization scheme, [c] coating process, [d] close view of penetration test, [e] force diagram and [f] puncture results

References

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