

Tuning Biotribological Response of Additively Manufactured CoCrMo via 2D MXene Reinforcement

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Abstract

The long-term performance of orthopaedic joint replacements is critically governed by frictional stability and wear resistance under boundary lubrication conditions. Building upon our recent review [1] and previous feasibility study, this work investigates the concentration-dependent biotribological behaviour of additively manufactured CoCrMo composites reinforced with $Ti_3C_2T_x$ MXene nanosheets. Composites containing 0–3 wt% MXene were fabricated via additive manufacturing and polished to implant-relevant surface quality. Reciprocating pin-on-plate experiments were conducted against UHMWPE under synovial joint-relevant conditions in phosphate-buffered saline. Friction response, stability, and statistical variability were systematically analysed to identify optimal reinforcement levels. The results revealed a pronounced concentration-dependent effect. While all reinforced variants modified interfacial behaviour compared to unreinforced CoCrMo, the composite containing 1 wt% MXene exhibited the lowest and most stable coefficient of friction (see Fig. 1). Higher MXene contents led to increased friction variability, suggesting the onset of agglomeration phenomena or third-body interactions. The findings indicate the presence of an optimal reinforcement window and highlight complex interfacial mechanisms beyond simple rule-of-mixtures assumptions. This study provides mechanistic insight into how 2D nanomaterials can be used to tune frictional behaviour of metallic biomaterials, supporting the development of next-generation additively manufactured joint implants.

References

- [1] Max Marian, Diana Berman, David Nečas, Nazanin Emami, Alessandro Ruggiero, Andreas Rosenkranz, *Advances in Colloid and Interface Science*, September (2022) 102747

Figures

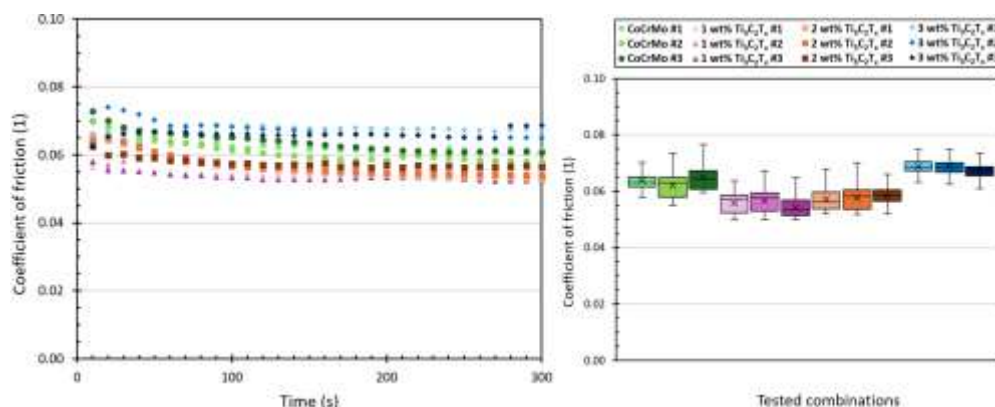


Figure 1: Time-dependent friction coefficient (left). The effect of MXene concentration (right).