# Revolutionizing Biomedical Implants: 3D-printed Metal Matrix Composites Reinforced with 2D MXenes

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Abstract
This study is motivated by a review article highlighting the potential of 2D materials in biomedical applications [1]. It explores an innovative method for enhancing 3D printing additive manufacturing by incorporating 2D MXene nanosheets into CoCrMo-based biomedical implants. The goal is to develop orthopedic implants with superior lubrication properties and minimal wear, catering to the demand for long-lasting synovial joint replacements. By improving wear resistance and extending implant lifespan, this approach aims to reduce revision surgeries and enhance patient care. As a feasibility study, CoCrMo metal pins were reinforced with 1 wt%, 2 wt%, and 3 wt% MXene nanosheets and polished to a 100 mm curvature radius, mimicking the surface of commercial joint implants (Fig. 1). Before evaluating biotribological performance, MXene biocompatibility was assessed through cytotoxicity tests. Mesenchymal stem cells (MSCs) were cultured on the reinforced samples for 2, 4, and 7 days, and their metabolic activity was measured using the MTT assay, confirming the absence of cytotoxic effects and suitability for biomedical use. Biotribological properties were tested using a pin-on-plate setup with reciprocating motion against a UHMWPE counterface at 20 mm/s for 5 minutes. Results showed notable frictional improvements as nanosheet content increased in MXene-reinforced samples compared to pure CoCrMo pins. Optical profilometry revealed fewer surface scratches, indicating enhanced wear resistance of the reinforced material. This study represents a key advancement in biomedical engineering, emphasizing the transformative potential of MXene-reinforced materials in orthopedic implants. By integrating superior mechanical properties with proven biocompatibility, this approach could revolutionize next-generation implant development.

References

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

Figures

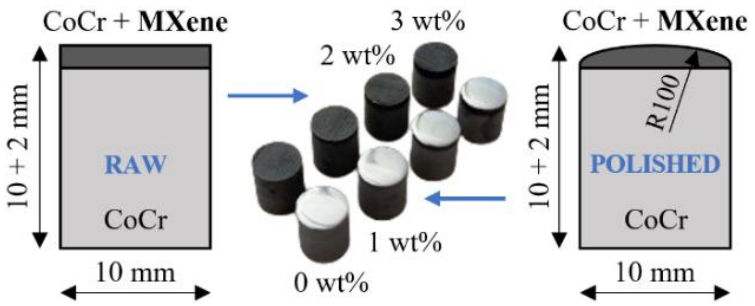


**Figure 1:** 3D-printed MXene-reinforced samples in raw and polished states.