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Amir Zadpoor
"Meta-biomaterials"

Amir Zadpoor is Antoni van Leeuwenhoek Professor and Chaired Professor of Biomaterials & Tissue Biomechanics at Delft University of Technology as well as Professor of Orthopedics at Leiden University Medical Center. He develops machine learning and 3D/4D (bio)printing techniques for the design and fabrication of metamaterials and tissues with unprecedented properties. Moreover, he is a world recognized expert in origami/kirigami-based (bio)materials combining shape shifting with additive manufacturing. Prof. Zadpoor has received many awards including an ERC grant, a Vidi grant, a Veni grant, the Jean Leray award of the European Society of Biomaterials, and the Early Career Award of JMBBM.

This talk centers on meta-biomaterials, unique biomaterials with distinct geometrical, physical, and biological properties derived from their small-scale design. These materials offer potential in tissue regeneration, infection prevention, and various biomedical applications. Three primary challenges in meta-biomaterials research are addressed: design, manufacturing, and performance evaluation. The "rational design" process leverages computational models, artificial intelligence, and mathematical techniques to create complex geometries and spatial distributions. Manufacturing these intricate designs requires specialized techniques, including 3D and 4D printing, origami, and kirigami. Finally, evaluating the performance involves in vitro, ex vivo, on-chip, and in vivo assays. Developments at macro-, micro-, and nanoscales are discussed, focusing on meta-biomaterials for treating complex bony diseases. Macro-scale applications cover patient-specific and deployable implants, while micro-scale considerations include auxetic meta-biomaterials and multi-material 3D printing. Nanoscale discussions revolve around nanopatterns for enhanced osteointegration, bactericidal properties, and immune response modulation. Future research will focus on biological performance and the interaction of these materials with multiple cell types under realistic biomechanical conditions, particularly involving osteoimmunomodulatory pathways. This represents the next crucial step in the advancement of meta-biomaterials.