The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

WANG TILES FOR EXPLORING AND MANUFACTURING MODULAR METAMATERIALS

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Keywords: *Non-periodic mechanical metamaterials, combinatorial design, robot-assisted manufacturing, centimeter-scale self-assembly*

Proposed originally as a visual aid for proving theorems in mathematical logic [1], Wang tilings have found subsequent applications in computer graphics, statistical physics, or biological computing. In this contribution, we discuss the use of Wang tilings in the design, manufacturing, and self-assembly of architectured (meta)materials.

The talk splits into three parts. The first part addresses the tiling concept in its most straightforward installment [2], which employs a single parent tile, possibly rotated by 90 degrees, that allows assembling structures with a locally-controlled Poisson ratio.

In the second part, we show that the elementary scenario naturally extends to the framework of vertex-based Wang tilings and demonstrate its use in the design of a soft porous metamaterial with a non-periodic structure. Here, the emphasis is put on the inherent modularity of this concept and its potential for scalable robot-assisted manufacturing.

The third part of the talk is devoted to exploring the potential of Wang tiling formalism in centimeter-scale passive self-assembly of target patterns. To this purpose, we present a design principle for magneto-mechanical tiles [3] that self-assemble in a checkerboard pattern under external mechanical excitation while exhibiting robust error-correcting features during the self-assembly process. Finally, intrinsic limitations of this approach are discussed, along with a simulation-supported strategy for increasing the size of self-assembled patterns.

This work was supported by the Czech Science Foundation project No. 19-26143X.

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