14th World Congress on Computational Mechanics (WCCM XIV)
8th European Congress on Computational Methods in Applied Science and Engineering (ECCOMAS 2020)
July 19- 24, 2020, Paris, France

COMPUTATIONAL SIMULATIONS OF INSTABILITY PHENOMENA FROM THE NANO- TO THE MACRO-SCALE

TRACK NUMBER 900

MELANIE TODT [*]***, FRANZ G. RAMMERSTORFER*** [†]

[*] TU Wien, Institute of Lightweight Design and Structural Biomechanics
Getreidemarkt 9, 1060 Vienna, Austria
mt@ilsb.tuwien.ac.at

[†] TU Wien, Institute of Lightweight Design and Structural Biomechanics
Getreidemarkt 9, 1060 Vienna, Austria
ra@ilsb.tuwien.ac.at

Key words: Structural Instabilities, Multiscale Modeling, Multi-Method Approaches

ABSTRACT

Structural instability phenomena, e.g., buckling, occur on various length scales. In engineering design, buckling is mainly considered on the macro-scale and is typically treated as failure mode. There, simulations aim at determining the critical loading state and the initial post-buckling behaviour.

On the nano-meter and micro-meter scale, the purpose of stability analyses is not primarily determining critical loading states but rather explaining phenomena observed in experiments and finding mechanisms that trigger the occurrence of instabilities. Examples are studies on the growth limit of carbon onions [1], or the pattern formation in soft matter such as hydrogels, or biofilms [2]. There are situations in which the appearance of instabilities is even be exploited for particular purposes. Examples for this are the pattern transformation in metamaterials [3] or the determination of interface parameters in thin-film substrate systems [1].

Often, it is the case that instabilities at lower length scales influence the structural behaviour on higher length scales. For instance, buckling of fibers in fiber reinforced materials reduces the structure's stiffness, and, in consequence, global structural instability may appear at significantly lower load levels than predicted without taking such multi-scale effects into account.

Moreover, buckling is typically related to compressive loading. However, there are several situations in which tensile loading results in buckling. Overlooking such possibilities in structural design may lead to unexpected failure.

The objective of this Minisymposium is to bring together experts from various disciplines ranging from physics, biomechanics, and material mechanics to structural mechanics for discussing recent advances in computational methods as well as for presenting uncommon

phenomena related to instabilities.

Contributions on advanced simulation methods, including atomistic simulation techniques, continuum mechanical methods, and multi-scale / multi-method approaches as well as on applications of these methods for investigating instabilities on various length scales are within the scope of this Minisymposium.

REFERENCES

[1] M. Todt, F. Toth, M.A. Hartmann, D. Holec, M.J. Cordill, F.D. Fischer, and F.G. Rammerstorfer, "Computational Simulation of Instability Phenomena in Nanoparticles and Nanofilms", Comput. Technol. Rev., Vol. ***10***, pp. 89–119, (2014).

[2] B. Li, Y.P. Cao, X.Q. Feng, and H. Gao, "Mechanics of morphological instabilities and surface wrinkling in soft materials: a review", Soft Mat., Vol. ***8***, 5728–5745, (2012).

[3] X. Yu, J. Zhou, H. Liang, Z. Jiang, and L. Wu, "Mechanical metamaterials associated with stiffness, rigidity and compressibility: A brief review", Prog. Mater. Sci., Vol. ***94***, 114–173, (2018).