# SUPERELASTICITY IN SHAPE MEMORY ALLOYS VIA PERIDYNAMICS

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The work is devoted to modeling the phenomenon of superelasticity, that is present in shape memory alloys (SMA), making use of peridynamics. SMA are a type of smart materials, in which solid phase transformations can be activated either by temperature change or external load. As found in the literature, there are known attempts at simulations of phase transformations in SMA introducing the above-mentioned nonlocal modeling technique. The superelasticity specifically refers to reversible phase changes, i.e. austenite-martensite-austenite, observed in SMA due to cyclic external force loading and unloading. As a consequence, the strain-stress characteristics exhibit hysteretic behavior. However, no temperature variation is needed for superelasticity to initiate phase transformations, as it applies in case of both one- and two-way shape memory effects. Due to the specific properties of SMA, the mechanical components made of this type of material allow to build structures which exhibit dissipation of considerable amount of energy in relatively short time periods.

Having introduced a peridynamic model for a solid body made of SMA, quasi-static numerical calculations are performed to build a stress-strain characteristics. The reference for the obtained results is provided with the outcomes from finite element analyses. The modelling capabilities of peridynamics for SMA are discussed.

## REFERENCES

[1] E. Madenci and E. Oterkus, *Peridynamic theory and its applications*. Springer, New York, 2014.

[2] A. Martowicz, Peridynamics for damage modelling and propagation via numerical simulations. *Diagnostyka*, Vol. **18**(1), pp. 73-78, 2017.

[3] K. Dayal and K. Bhattacharya, Kinetics of phase transformations in the peridynamic formulation of continuum mechanics. *Journal of the Mechanics and Physics of Solids*, Vol. **54**(9), pp. 1811-1842, 2006.