GEMS: A MEMS-based Way for the Innervation of Materials

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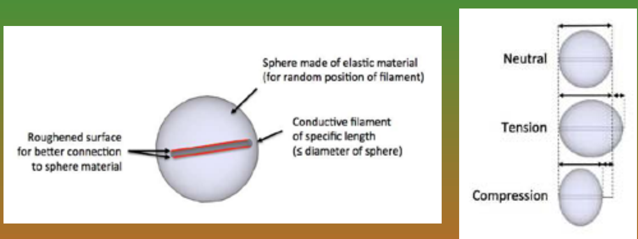
Abstract

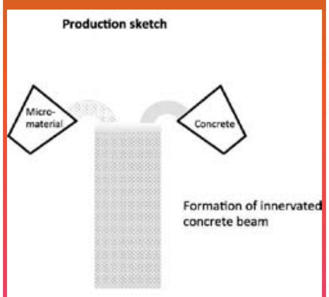
We introduce a concept for a novel 'innervated' material that is assembled by addition of a multitude of MEMS to a conventional material. This approach shall enable the material to show specific reactions to external inputs, and make the reaction accessible to external observers. By implementing such innervated material into buildings, clothing or even food, it would be possible to create a virtual neural system in objects.

MEMS-based Innervated Material: Concept Development

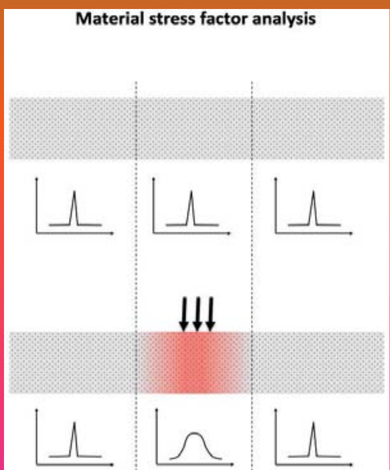
- Group Electro-Mechanical Systems (GEMS) are a specific form of MEMS that are simpler than conventional MEMS and that contribute as parts of a group to a joint signal.
- GEMS are basic ingredients of the proposed innervated material.
- The single MEMS can be compressed or elongated, with the filament being longer or shorter compared to the neutral case. The setup of the GEMS is the simplest possible given the requested features, to allow for mass production and failsafe function (access problems in the final innervated material – no repair/replacement possible).



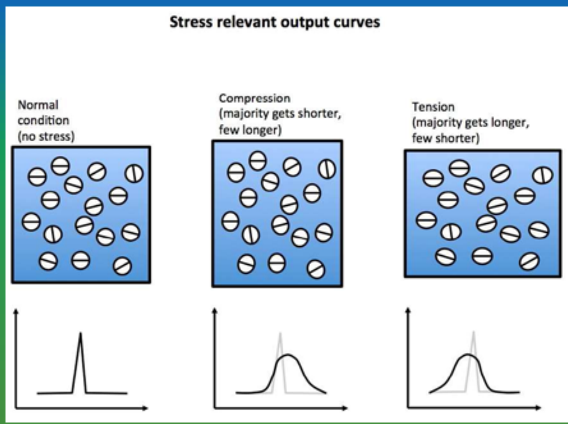
Left: GEMS for the innervation of materials. Right: Effect of mechanical stress and strain on the GEMS



Production of a concrete beam made from innervated material: GEMS are mixed with concrete, shaped as beam, and allowed to harden.



The characteristic responses of the innervated material along a beam. Top: Normal condition, no compression or tension along the beam. The signal is the same along the structure. Bottom: Signal change induced by a compression/tension state in the middle section of the beam (red area).



The characteristic responses of the innervated material, exemplified for the normal condition (left), the compression condition (when the majority of the GEMS gets shorter, some stay the same length and only some get longer) and the tension condition (when the majority of the GEMS gets longer, some stay the same length and only some get shorter). The top images give a sketch of the GEMS embedded in the matrix, and the bottom images the characteristic resulting induction vs. time curves.

Outlook

- Introduces the concept of a novel innervated material that allows external observers to determine its stress or strain status.
- Tension or compression of the spheres results in shortening or elongation of the metal rods. When a frequency sweep is applied to the innervated material, the induction vs. time curve gives information on the status of the innervated material, and therefore allows for stress factor analysis.
- The GEMS introduced here are the simplest possible ones, they are passive and do not actively communicate with each other.
- Active GEMS would open up a whole new area of possible applications, but are not treated here because of space constraints.
- The impact of material innervated with active and passive GEMS on the future of engineering would be enormous.

References:

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