RESONANT ULTRASOUND SPECTROSCOPY OF SUMPTUOUS SOFT SOLIDS

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The multisensory perception of common solid bar materials like lipstick, deodorant, soap, or chocolate is determined in part by their visco-elastic properties, which in turn depend on the detailed material structure. Efficient processing of such materials is also highly dependent on their mechanical behavior, which can be a complex function of composition, crystallinity, and temperature.

Resonant Ultrasound Spectroscopy (RUS) probes the mechanical structure of a small sample of well-defined geometry by measuring a set of consecutive low-lying vibrational modes and then using the frequencies and linewidths to constrain the material's visco-elastic constants. RUS has been used largely to study hard crystalline materials by looking at elastic constants, phase behavior, and nonlinear interactions, and to perform nondestructive testing of commercial parts [1-5].

Investigation of soft and highly dissipative materials with RUS is less common and involves a number of challenges due to the low frequency values and large linewidths of the acoustic modes of the system, resulting in highly overlapping peaks. To overcome the challenges presented by soft materials, we employ a combination of techniques to allow the unique identification of the vibrational modes. These include the use of different transducers for selective excitation, judicious choices of sample geometry and orientation, and careful numerical fitting of resonant lineshapes.

We will discuss our progress in applying this technique to the study of the development and characterization of new soft "everyday" materials. We will present preliminary results on "test" soft materials as well as model formulations of materials of common interest. Parameters we can vary include crystal size, humidity, and crystalline anisotropy.

The audience will be invited to perform ad hoc mechanical tests of some of the tastier samples to illustrate the correlation between elastic and sensory properties.

References

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