

Research paper

Hyper-frequency viscoelastic spectroscopy of biomaterials

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ABSTRACT

With the emergence of new biomaterials and elastography imaging techniques, there is a need for innovative instruments dedicated to viscoelasticity measurements. In this work, we introduce a novel hyper-frequency viscoelastic spectroscopy (HFVS) technique dedicated to characterize soft media subjected to mid-to-very-high frequency stress ranges (or, equivalently, to probe short-to-very-short relaxation times). HFVS, which has been implemented in an analytical instrument performing non-contact measurements in less than 1 s between 10 and 1000 Hz, is a suitable tool to study viscoelasticity for bio-applications. In this context, HFVS has been compared to classical oscillatory rheometry on several classes of soft materials currently encountered in tissue repair, bioengineering and elastography imaging on a frequency range between 10 and 100 Hz. After having demonstrated the good correspondence between HFVS and rheometry, this study has been completed by exploring the sensitivity of HFVS to physicochemically induced variations of viscoelasticity. HFVS opens promising perspectives in the challenging field of biomaterial science and for viscoelasticity-based quality control of materials.

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1. Introduction

Emerging research fields such as tissue replacement and engineering, injected biomaterials in tissue regeneration context, cellular mechanical transduction and elastography imaging require a good understanding and mastering of soft material mechanical properties. In most cases, viscoelastic properties play a major role in the relevance of elastography imaging for diagnostic purposes, as well as in the safety and the efficiency of biomaterial-based therapies and repair techniques.

Existing technologies for rheological characterization of soft solid materials (Ferry, 1980), like rotational rheometers and dynamic mechanical analysis (DMA), proved their

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