Ultrasensitive Micro String Resonators for Solid State Thermomechanical Analysis of Small and Large Molecules - DTU Orbit (27/09/2019)

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Thermal analysis plays an important role in both industrial and fundamental research and is widely used to study thermal characteristics of a variety of materials. However, despite considerable effort using different techniques, research struggles to resolve the physico-chemical nature of many thermal transitions such as amorphous relaxations or structural changes in proteins. To overcome the limitations in sensitivity of conventional techniques and to gain new insight into the thermal and mechanical properties of small and large molecule samples, we have developed an instrumental analysis technique using resonating low stress silicon nitride microstrings. With a simple sample deposition method and post process data analysis, we are able to perform rapid thermal analysis of direct instrumental triplicate samples with only pico- to nanograms of material. Utilizing this method, we present the first measurement of amorphous alpha and beta relaxation, as well as liquid crystalline transitions and decomposition of small molecule samples deposited onto a micro string resonator. Furthermore, sensitive measurements of the glass transition of polymers and yet unresolved thermal responses of proteins below their apparent denaturation temperature, which seem to include the true solid state glass transition of pure protein, are reported. Where applicable, thermal events detected with the setup were in good agreement with conventional techniques such as differential scanning calorimetry and dynamic mechanical analysis. The sensitive detection of even subtle thermal transitions highlights further possibilities and applications of resonating microstrings in instrumental physico-chemical analysis.

General information
Publication status: Published
Organisations: Nanoprobes, Department of Micro- and Nanotechnology, Center for Intelligent Drug Delivery and Sensing Using Microcontainers and Nanomechanics, University of Copenhagen
Corresponding author: Rades, T.
Pages: 17522-17531
Publication date: 2018
Peer-reviewed: Yes

Publication information
Journal: Journal of the American Chemical Society
Volume: 140
Issue number: 50
ISSN (Print): 0002-7863
Ratings:
BFI (2018): BFI-level 2
Scopus rating (2018): CiteScore 14.75 SJR 7.468 SNIP 2.634
Web of Science (2018): Indexed yes
Original language: English
Keywords: Thermal analysis, MEMS, Resonator, String, β-relaxation, Glass transition
DOIs: 10.1021/jacs.8b09034
Source: FindIt
Source ID: 2441892463
Research output: Contribution to journal › Journal article – Annual report year: 2018 › Research › peer-review