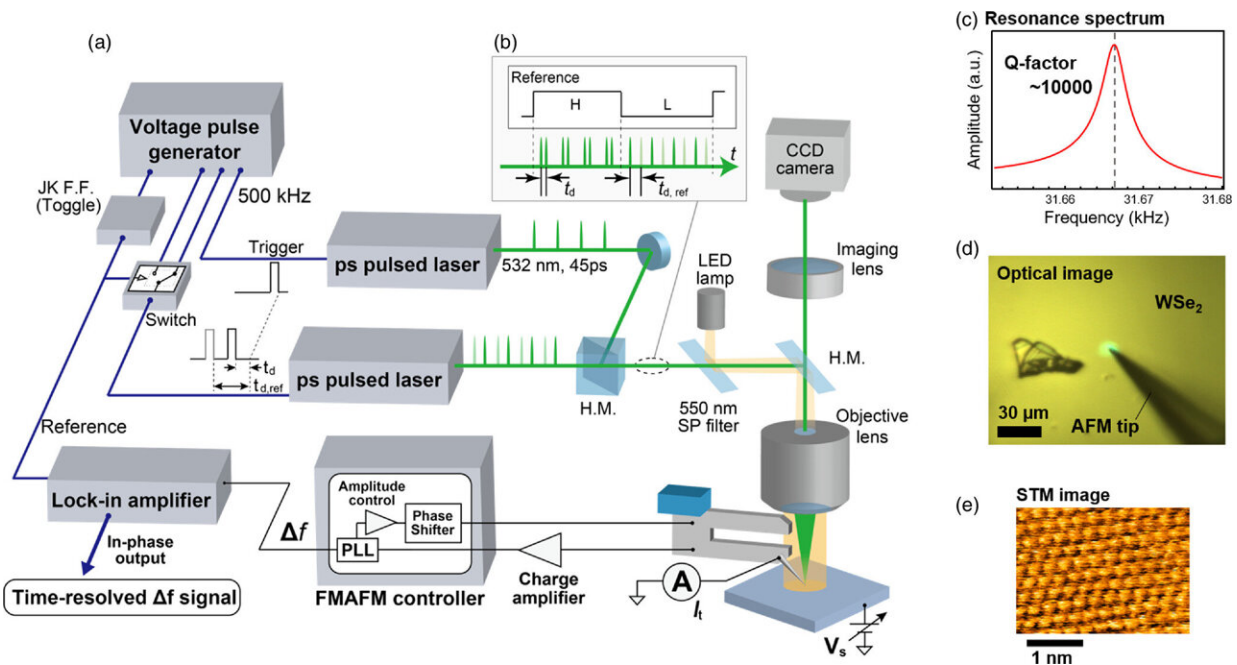


Novel time-resolved atomic force microscopy technique captures ultrafast light-induced phenomena

January 31 2024



(a) Schematic of the time-resolved FM-AFM system developed. H.M.: Half mirror, JK F. F.: JK flip flop, SP filter: short-pass filter. (b) Delay time modulation scheme. By adjusting the timing of H/L voltage sequence from JK F.F., the delay time modulation between (H, delay time = t_d) and (L, delay time = $t_{d, ref}$), as shown in the figure, occurs. (c) Resonance characteristics measured to determine the Q-factor ($\sim 10,000$). (d) CCD image of measurement setup. (e) Atomically resolved STM image of a bulk WSe₂ sample. Credit: *Applied Physics Express* (2023). DOI: 10.35848/1882-0786/ad0c04

Despite remarkable progress in science and technology, rapid advancements have exposed limitations in many technological domains. A pressing challenge in semiconductor devices, which underpin ultrahigh-speed communications and artificial intelligence (AI), is the development of high-performance devices with a basic structure of 2 nanometers (nm).

At this scale, single-atom defect structures and minor electron behavior disturbances considerably affect macroscopic phenomena, playing a crucial role in device functionality. Therefore, understanding and controlling high-speed physical and chemical phenomena at the [nanometer scale](#) is vital for developing high-performance devices.

The research team previously developed a time-resolved scanning tunneling microscopy (STM) method, combining STM with [laser technology](#), to attain nanolevel spatial resolution and femtosecond temporal resolution. This method has been instrumental in elucidating various photoexcited dynamics. However, STM's reliance on electric current flow between the probe and sample limits its application to conductive materials.

In their study, [published](#) in *Applied Physics Express*, the team has developed a new time-resolved AFM system, enhancing its operability by merging AFM with their unique ultrashort laser pulse technology. This development allows for the measurement of high-speed dynamics in a broader range of materials, including insulators, with nanometer resolution.

A unique approach to counteract the thermal expansion of the probe and sample due to laser irradiation has enabled the acquisition of time-resolved signals with an exceptionally high signal-to-noise (SN) ratio. In addition, laser oscillation is electrically controlled to enhance operability.

The ability of AFM to measure a diverse range of objects positions the technology developed in this research to have widespread applications, extending beyond academic research to industries, medicine, and other fields. It is anticipated to facilitate the discovery of new principles and the genesis of new fields by considerably broadening the scope of exploration.

More information: Hiroyuki Mogi et al, Time-resolved force microscopy using the delay-time modulation method, *Applied Physics Express* (2023). [DOI: 10.35848/1882-0786/ad0c04](https://doi.org/10.35848/1882-0786/ad0c04)

Provided by University of Tsukuba

Citation: Novel time-resolved atomic force microscopy technique captures ultrafast light-induced phenomena (2024, January 31) retrieved 28 April 2024 from <https://phys.org/news/2024-01-atomic-microscopy-technique-captures-ultrafast.html>

This document is subject to copyright. Apart from any fair dealing for the purpose of private study or research, no part may be reproduced without the written permission. The content is provided for information purposes only.