Complex cantilever dynamics reconstructed by wavelet transforms

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One of the recent developments of AFM concerns the band excitation method and the associated nonlinear cantilever dynamics [1]. In order to measure material parameters, information on peak force of interaction, energy dissipation and contact dynamics is required. We propose a data analysis to retrieve these quantities during impulsive cantilever excitation that has general relevance. As an example, we demonstrate that the information already present in a standard force curve in air can be exploited to reconstruct the tip trajectory after the jump-to-contact impact (at time zero in the figures) using a cross-correlation wavelet analysis [2]. The wavelet analysis identifies the time evolution (amplitude and phase) of the transiently excited spectra of each flexural mode upon impact (see arrows in Figure 1, A) [3]. From this analysis the photodiode signal after the impact is obtained as a sum of excited mode contributions (in a 200 μs time window, see Figure 1, B). The tip trajectory can be retrieved by scaling the mode contributions according to the deflection-system sensitivity. The trajectory reconstruction naturally stems from wavelet analysis and is not the result of a fitting procedure. This work has been partially supported by Università Cattolica through D.2.2 grants.

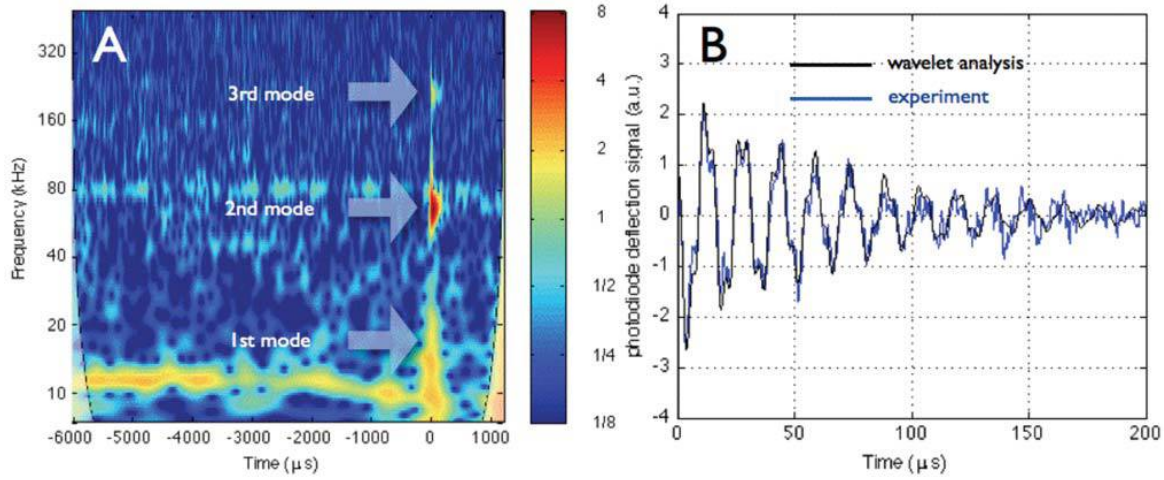

Figure 1

References

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[3] G. Malegori, G. Ferrini, Wavelet transforms to probe long- and short-range forces by thermally excited dynamic force spectroscopy, *Nanotechnology* **22**, 195702 (2011).