ORGANIZED BY
UNITED RESEARCH FORUM
(CONNECT WITH RESEARCH WORLD)

GLOBAL SUMMIT ON ADVANCED MATERIALS SCIENCE AND NANOTECHNOLOGY

Cagri Yilmaz

Akdeniz University/Vocational School of Technical Sciences / Mechatronics Department, Antalya, Türkiye

Mathieu-type nonlinear responses of the resonantly excited micro-cantilever to viscous loads for varying elastic stiffness and quality factors

Abstract: The sensitivity of the micro-cantilevers to target external forces in different environments can be improved by resonating them in monomodal and multimodal operations. Different types of external forces can simultaneously act the resonantly driven micro-cantilevers which interact with the biological samples or function with microelectromechanical devices. Correspondingly, determining the proper properties of the micro-cantilevers for different flexural eigenmodes is quite crucial to achieve the desired micro-cantilever sensitivity. In rheological applications, nonlinear models can be used to predict micro-cantilever behaviors in different fluids. Dynamic responses at the first two flexural eigenmodes considerably change in response to varying excitation amplitudes in the Mathieu function. Out-of-plane displacements of the micro-cantilevers are strongly responsive to varying elastic stiffness and quality factors. It is worth mentioning that the equilibrium position is higher for the smallest elastic stiffness of 0.9 N/m at the first flexural eigenmode. Furthermore, hydrodynamic loads determined using Sader's functions induce non-periodic oscillations. Hydrodynamic peak forces mostly ascend with increasing dynamic viscosity and density as expected. More deterministic hydrodynamic force patterns are also obtained for different quality factors at the first flexural eigenmode when compared with the higher flexural eigenmode. Observable sensitivity to viscous loads can be enhanced by selecting proper quality factors of the micro-cantilever, especially at the fundamental eigenmode. Therefore, nonlinear models can be robustly utilized to reflect the hydrodynamics of resonating micro-cantilevers with different mechanical properties.

Keywords: hydrodynamic sensitivity, micro-cantilever, elastic stiffness, quality factor, Mathieu function, higher flexural eigenmode

Biography: Cagri Yilmaz received his undergraduate degree in mechanical engineering from Middle East Technical University (METU) in 2007. He went on to complete his master's degree in mechanical engineering at Duisburg-Essen University in Germany in 2010. He worked as an intern in the manufacturing department at ThyssenKrupp MillServices & Systems in Duisburg. In 2010, he successfully completed his master's thesis at Trützchler Spinning firm in Mönchengladbach, Germany, as part of the T-Data project. Subsequently, he worked as a research assistant in the Distributed Artificial Intelligence Laboratory (Dai-Labor) at the Technical University of Berlin from 2011 to 2014, focusing on robot systems and smart grids. He completed his doctoral studies in the field of acoustics and vibration at Akdeniz University's mechanical engineering department in may 2022. Currently, he is engaged in theoretical studies on the sensitivities of micro-cantilevers to external forces under multi-frequency operations.

ISBN: 978-1-0685851-0-4