Analysis of compressional mode excitation in an air capacitor configuration for a controlled Karabut experiment

#P. L. Hagelstein
Research Laboratory of Electronics, MIT, Cambridge, MA, plh@mit.edu

Karabut has reported the observation of collimated x-rays near 1.5 keV from an experiment done in a high-current glow discharge, which is a result that we consider to be one of the most important in the field of condensed matter nuclear science. We have interpreted this experiment as demonstrating coherent energy transfer between a highly-excited acoustic vibrational mode near 50 MHz and the 1565 eV transition in ^{201}Hg. This nuclear transition is special in that it is the lowest energy transition from the ground state in any stable nucleus.

During the past year we have worked on the design of a controlled version of the Karabut experiment. If our interpretation of the experiment is correct, then what is required to create the collimated x-rays includes strong excitation of the lowest compressional mode of the metal cathode, and deposition of mercury on the cathode surface. Neither of these effects are controlled in Karabut's experiment. We are interested in the development of a new experiment in which we excite a compressional mode that we choose at its resonant frequency, with an excitation level determined by the stimulation that we apply, and with a measurement of the supplied power to the vibrational mode.

We have proposed for this the simplest possible configuration of an air capacitor that is driven at a frequency half of the resonant frequency of the target mode. The coupled electric and mechanical problem that results is sufficiently simple that it is nearly a homework problem in an engineering class, and we are able to develop analytical results throughout for the mechanical displacement as a function of the applied voltage.

In this presentation we will describe the proposed experiment, and describe the proposed air capacitor system in detail. The associated elastic model based on mode solutions of the Naviar equation in cylindrical coordinates will be described, and analytic relations between the mode energy and dissipated power will be given in terms of the drive voltage. We have developed a numerical example in which a disk similar in size and shape to cathodes used by Karabut are driven to a level of excitation that we estimated last year might have been achieved in Karabut's experiment.

This analysis was done in order to support an experimental effort aimed at demonstrating coherent energy exchange between the vibrational mode and surface ^{201}Hg mercury nuclei that we hope to pursue this year.