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ABSTRACT

It is known that singly corrugated surfaces have the ability to stimulate surface acoustic waves by means of diffraction. However, this diffraction occurs in a single plane. Sound impinging a doubly corrugated surface is scattered in many directions. Therefore, such surfaces possess the ability to generate surface waves in many directions, depending on the corrugation and depending on the frequency. Numerical simulation is possible if continuity of stress and strain are considered. The present paper reports advanced numerical simulations based on all physical parameters of the system and shows what surface waves are generated, under what conditions and under what angle. Such a device may be used to send surface waves in directions that are determined by their frequency.

KEYWORDS: Diffraction, SAW-devices, ultrasound

INTRODUCTION

Doubly corrugated surfaces are surfaces that look like egg-crates. They posses the ability to diffract sound into all possible directions. They also possess the ability to function as SAW-devices.
There are several papers available, applying many different methods, on the diffraction of sound by singly corrugated surfaces. Many of them are listed in the book of Mayste [1]. The diffraction of sound on doubly corrugated surfaces (‘egg crates’) has only been sporadically taken under consideration in the literature [2,3,4,5].

The current paper follows the method of Claeyts et al [10,11] and Mampaert et al [9-11] for incident homogeneous plane waves and the extension of Briers et al [6-8] for inhomogeneous plane waves. This latter particular method applies a decomposition of the diffracted wave fields into inhomogeneous waves that travel each in a direction, and have an inhomogeneity, governed by the classical grating equation and the dispersion relation. This method has only been performed until now on singly corrugated surfaces, where it has been experimentally verified for incident homogeneous plane waves [9-11] as well as for incident inhomogeneous plane waves [8]. In the discussion below, we omit the time dependence $\exp(-i\omega t)$ of the sound field, since this factor can be added at any time in the results without altering any of the developed equations.

**BOUNDARY CONDITIONS AND DESCRIPTION OF THE ACOUSTIC FIELD**

The doubly corrugated interface is described as

$$z = f(x,y) = f_x(x) + f_y(y)$$

with

$$f_x(x + A_x) = f_x(x) \text{ and } f_y(y + A_y) = f_y(y)$$

whence the boundary condition is given by

$$g(x,y) = f(x,y) - z = 0$$

Taking into account the Rayleigh decomposition of the acoustic field and taking into account the characteristics of dilatational and shear waves, one may now write the incident waves $N^{inc}$, the (dilatational) reflected waves $N^r$, the dilatational respectively shear transmitted waves $N^d$ and $N^s$, as

$$N^{inc} = A^{inc} \phi^{inc} \left(ik_x^{inc} e_x + ik_y^{inc} e_y + ik_z^{inc} e_z\right)$$

$$N^r = \sum_{m,n} R^{m,n} \phi^{m,n,r} \left(ik_x^{m,n,r} e_x + ik_y^{m,n,r} e_y + ik_z^{m,n,r} e_z\right)$$

$$N^d = \sum_{m,n} A^{m,n,d} \phi^{m,n,d} \left(ik_x^{m,n,d} e_x + ik_y^{m,n,d} e_y + ik_z^{m,n,d} e_z\right)$$

$$N^s = \sum_{m,n} A^{m,n,s} P^{m,n,s} \phi^{m,n,s}$$

with