Broadband acoustic attenuation with multiresonant lossy three-dimensional sonic crystal for the train noise reduction

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A three dimensional (3D) locally resonant sonic crystal (LRSC) exploiting the multiple resonances and Bragg band gap of a periodic arrangement of scatterers is numerically and experimentally reported in this work producing a broadband acoustic attenuation. The LRSC is made of a square array of square cross-section rigid rod scatterers incorporating a periodic arrangement of quarter wavelength resonators (QWR) and Helmholtz resonators (HR). We exploit the coupling of the local resonant scatterers in order to generate multiple resonances at low frequencies below the Bragg band gap. These coupled resonances are combined with the effect of periodicity in order to produce a strong attenuation over a broadband frequency range with high insertion loss (IL) values. We show that this large IL covers three and a half octaves (from 350 Hz to 5000 Hz) with an average value of 16.8 dB in the range of frequencies between 50 Hz and 5000 Hz. This range of frequencies covers the one of the wheel noise of the train noise. Finally, a simplified 2D LRSC is numerically analyzed in a real geometry of train platform situation, showing the efficiency of the design presented in this work to attenuate wheel noise of trains.