Hearing Light: Light-Heat-Sound Transformation of a Jar and Its Thermodynamic Characteristics

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Photoacoustic effect has great potential applications in physics, medical, and material science. However, few works have been done on quantitative analysis of the sound intensity, which leads to an unnecessary energy loss in the system. To quantitatively investigate the sound and its relevant parameters, we performed on an interesting phenomenon Hearing Light, including the conversion of AC electricity into oscillating light, the light is then absorbed by carbon powder, which then triggers intermittent compression and expansion of the air within the jar, resulting in the generation of sound, fulfilling the light-heat-sound conversion. We first experimentally investigated this phenomenon and used an accurate method to record the sound. The energy transformation is then quantitatively discussed by setting up physical models of light generation, heat absorption and conduction, and mechanic motion of air. Key parameters of sound intensity were discussed, including AC light intensity, the geometry of the jar, and the modulation frequency of light. Our theoretical model perfectly explained the experimental results of the maximum light intensity at a certain modulation frequency and jar geometry. The establishment of this quantitative model and discussion of parameters can be utilized for improving the energy conversion efficiency for photoacoustic detection and experiment by choosing the best modulation frequency and jar geometry; generating and detecting double-frequency electronic, heat, and sound signal in a low-frequency range; detecting the Light-to-Heat Conversion Efficiency in a wide range of materials; and developing novel non-contact double frequency generators and detectors.