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Effect of electrical resistivity on ultrasonic attenuation in FeSe single crystal at low temperature

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The ultrasonic attenuation and velocities following electron viscosity mechanism has been computed in semi-metallic, superconducting single crystal Iron Selenide(FeSe) in low temperatures 10-70K. We have also calculated the electron-viscosity at different low temperature needed for the calculation of ultrasonic attenuation. The behaviour of ultrasonic attenuation is quite similar to its inverse electrical resistivity. The ultrasonic attenuation due to electron viscosity mechanism is most significant at 15 K. Computed results of ultrasonic parameters have been discussed.

Keywords: Elastic constant, electrical resistivity, superconductor, ultrasonic attenuation.

Introduction

Ultrasonics is a versatile tool for studying the properties of different types of materials. This is a useful technique for the characterization of microstructures, appraisal of defects, discontinuity and mechanical properties of objects. Ultrasonic measurements are very important during the material processing in the industries at different temperature to extract the internal microstructural and mechanical thermophysical properties of the materials. The interaction of ultrasound with microstructure is important for many material problems. Attenuation and backs scattering reduce the detectability of flaws, especially in materials with coarse grains or complex microstructures. The study of the propagation of ultrasonic waves in materials determines the elastic constants, which provides better understanding of the behaviour of the materials. The elastic constants of material are related with the fundamental solid state phenomenon such as specific heat, Debye temperature and Grüneisen parameters. The elastic constants in the materials can be determined by measuring the velocity of longitudinal and shear waves. The intensity of ultrasonic wave decreases with the distance from source during the propagation through the medium due to loss of energy. These losses are due to diffraction, scattering and absorption mechanisms, which take place in the medium. The changes in the physical properties and microstructure of the medium is attributed to absorption while shape and macroscopic structure are concerned to the diffraction and scattering. Ultrasonic velocity play important role in the study of ultrasonic attenuation. It is directly related to elastic constants by formula. $v = \sqrt{\frac{c}{\rho}}$ where c is the elastic constant and ρ is the density of that particular material[1,8]. Anisotropy stiffness and stability of the crystals are directly related to the elastic constants. Also the elastic constants provide the information about the Debye temperature and Debye average velocity at different temperatures.

The Understanding of the high temperature superconductivity mechanism is a prominent and challenging task facing the solid state physics community. Comparing the cuprate superconductor and the iron based superconductor provides the information that leads to explore the high temperature superconductivity. The iron-based superconductors discovered in 2008 represent the second class of high temperature superconductors. A great progress has been made in theoretical understanding