



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Acoustic Charge Transport in Organic Semiconductors using Surface Acoustic Wave Devices

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SHORT ABSTRACT

A surface acoustic wave (SAW) is a periodic deformation of the surface of an elastic material propagating at the surface primarily as a linear wave front. Despite the fact that their existence had already been established by Lord Rayleigh in 1885, it wasn't until 1965, through the development of the interdigital transducer (IDT), that they were first utilised for various applications. It is now feasible to stimulate and detect SAWs on a piezoelectric surface in an effective manner. It is established that SAW devices have a very broad range of applications in several fields. Professional radar and communications systems extensively use SAW delay lines, band pass filters, resonators, oscillators, and matched filters. SAW can also be employed as a pressure, humidity, and temperature sensor for chemical sensing and analysis purposes. SAW has very low velocity and narrow wavelengths, reducing size and weight and hence, can be mass manufactured. When a semiconductor comes into interaction with SAW, the acoustic deformations induced by SAW have a significant impact on the semiconductor's energy bands and, consequently, its electrical characteristics. SAW-induced band edge modulation leads to the spatial separation of charge carriers of a semiconductor. Furthermore, the energy and momentum carried by SAW are transmitted to charge carriers resulting in a dragging force on them. This phenomenon is known as the acoustoelectric effect, and the transport caused by this effect is termed acoustic charge transport (ACT). The process of ACT has been demonstrated by several researchers in inorganic semiconductors either by injecting carriers through an input bias or optically generating carriers. Organic semiconductors are increasingly being used as the active layer in a wide variety of innovative technologies due to their solution-processability, lightweight, and flexibility. In contrast to inorganic semiconductors, organic materials form a polycrystalline layer, and their charge transport is mostly limited by grain boundaries. Numerous studies have been done, throughout the past few years, to investigate the factors affecting and contributing to the charge transport of organic semiconductors. However, the interaction of an acoustic wave with these materials has not been reported yet. The primary objective of the thesis is to observe the charge transport of ambipolar electrons and holes in organic semiconductor films by means of acoustic waves and to investigate potential acousto-optic applications that may result from this interaction.