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Density of states in $Bi_{12}TiO_{20}$ from time-of-flight measurements

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Abstract

Two sillenite crystals of $Bi_{12}TiO_{20}$, one intrinsic and one lead doped, have been studied by means of the time-of-flight (TOF) experiment. After a short presentation of the technique, we return to the different methods proposed to extract the transit time from the current transients recorded with the TOF experiment. Further, we illustrate the possibility of extracting the density of states from these transients by means of a Laplace transform applied to the variation with time of the transient currents. Then we present some experimental results. The room temperature drift mobilities we measured were equal to 2 and 0.2 $cm^2\ V^{-1}\ s^{-1}$ for the lead doped and intrinsic sample, respectively. Finally we present the densities of states found for each crystal and compare them to the results obtained from modulated photocurrent experiments applied to the same samples.

(Some figures in this article are in colour only in the electronic version)

1. Introduction

Many methods developed to investigate the transport properties of highly resistive semiconductors are based on the photoconductive properties of these materials [1]. Among these techniques the time-of-flight (TOF) technique, proposed decades ago by Spear [2], has been largely applied since then to a large variety of materials such as semi-insulating crystals [3–5], amorphous semiconductor thin films [6, 7], chalcogenides [8, 9] and polymers [10, 11]. First developed to deduce both hole and electron mobility values, for it gives the opportunity to choose the type of carriers drifting through the sample, it was later considered as a mean to deduce more information on the material properties such as the defect densities of localized states present in the gap. Various models of transport and interactions of carriers with trapping states have been elaborated (continuous time random walk [12], or multiple trapping [13–15]) mostly for crystalline or disordered semiconductors, whereas transport models in polymers