Micro-FTIR: From Plasmon Frequency to Dopant Concentration Mapping

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Traditionally, FTIR is used in order to characterize the phonon features for a material, or in the case of doped semiconductors towards the identification of the plasmon frequency that is correlated with the free carrier concentration. The aim of this work is to present an innovative process towards the mapping of the dopant concentration in a semiconductor using μ-FTIR technique.

Materials used in this study were $Mg_2Si_{1-X}Bi_X$ ($0 \leq x \leq 0.035$) hot pressed pellets. Room temperature IR measurements were performed with near normal light incidence in the range of 500-4000cm^{-1} using the microscope i-series Perkin Elmer, with 100μm iris, which enables FTIR mapping of the sample. Each obtained experimental reflectivity spectrum was fitted by applying the conventional Drude model.

The chemical composition of the sample was determined by EDS and SEM analyses using a Jeol 840A scanning microscope with an energy-dispersive spectrometer attached (model ISIS 300; Oxford). Room temperature Hall effect measurements were carried out using Van der Pauw configuration, with the magnetic field up to 1.2 T.

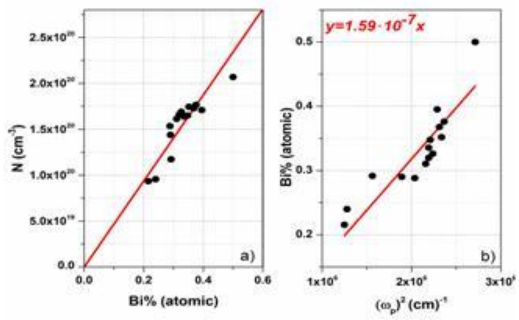

Figure 1
(a) Theoretical (line) and experimental (points) increase of the free carrier concentration (N) vs. Bi-content (b) Plasma minimum $(\omega_p)^2$ as derived from the fitting of reflectivity spectra. Theoretical curve assumes that each Bi atom contributes to one free electron per unit cell in Mg_2Si.

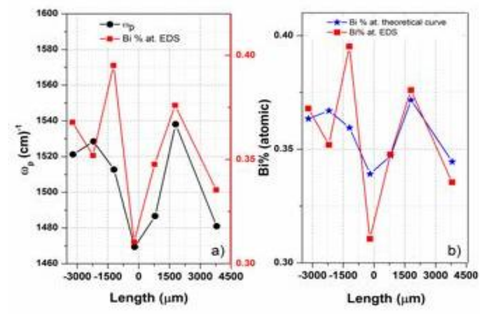

Figure 2
(a) Variation of the plasma frequency (black circles, yielded from μ-FTIR) as well as of the Bi content (red squares, by EDS in right y-axis) across the length of a sample with x=0.35% Bi. b) Bi% content variation defined through two approaches; SEM/EDS and through μ-FTIR.

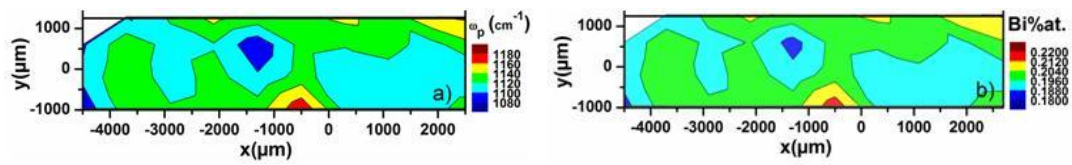

Figure 3
Contour plots of a bar-shaped sample with average Bi content 0.2% at. Left plot presents the mapping of the plasmon frequency. Right plot depicts the dopant concentration mapping.

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