Quodons in Mica 2013
Meeting in honour of Prof. Mike Russell.

Experimental observation of moving discrete breathers in Germanium

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Keywords: ILM, breather, electric traps, germanium, DLTS

Abstract

Los energy ICP Plasma produce Atoms that arrive at a semiconductor surface with very low energy (2-8 eV) but are able to anneal defects deep inside the semiconductor [1], as shown in the figure. The number of defects before and after plasma irradiation is obtained through the well proven technique of Deep Level Transient Spectroscopy (DLTS) [2].

Several different defects were removed or modified in Sb-doped germanium, some of the them are known, such as the E center, which has the highest concentration. After eliminating other possibilities (electric field, light, heat) we now conclude that moving discrete breathers (DBs)[3], as a mechanism of long-distance energy transport, are the most likely cause. Stationary and moving breathers have been found recently by molecular dynamics in different materials with energies from 0.1 eV to a few eV [4,5]. The mechanism of annealing is an activated process, and discrete breathers have already been shown to accelerate this type of processes [6].

This would be a striking evidence of the importance of DBs in crystals and opens the way to further experiments to probe DB properties both in semiconductors and in the metals used for contacts. Most of the measurements have been done in germanium, but also it have been shown that similar effects take place in silicon.

Acknowledgements: The authors' research was funded by the following institutions: JFRA by project FIS2008-04848 from MICINN. SMM and FDA by the South African National Research Foundation. VH by the European Union through the European Regional Development Fund (Centre of Excellence *Mesosystems: Theory and Applications*.

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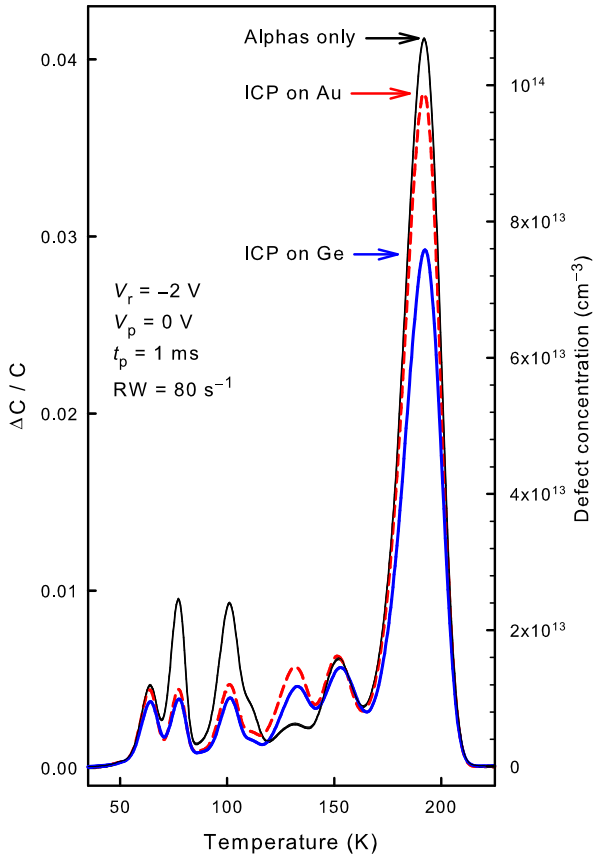

Figure 1: Three DLTS spectra performed in Sb-doped Ge after being damaged by 5 MeV α particles followed by 24 hours or room temperature annealing. The labels at the right Y-axis indicate the defect concentration at the respective peaks and are meaningless otherwise. Black (thin line): before ICP; red (dashed): after 30' ICP through an Au contact; blue (thick line): after 30' ICP directly on Ge. See text for explanation. The highest peak at 185 K corresponds to the E center defect.