Metastable Defects

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Defect metastability refers to defects that, for at least one charge state, can occur in more than one configuration. Even for defect as simple as the Si self-interstitial, ab-initio calculations predict a number of theoretical metastable configurations in which the defect can occur. For defect metastability to be detectable by means of electrical measurements such as DLTS, the configuration of the defect has to influence the properties of a level in the band gap caused by the defect. Furthermore, it must be possible to switch the defect from one state to the other by electrical or other means.

A number of phenomena in semiconductors have been associated with metastable defects. These include persistent photoconductivity as well DLTS peaks which can be removed and re-introduced by forward and reverse bias annealing. The result is that the electrical properties of the device no longer depend only on the current conditions, but also on the history of the device itself. Technologically, metastable defects are important, as their presence in in a device may lead to erratic behaviour, as in the case of the Thermal Donor in Silicon. For theoretical studies, ab-initio investigations into the metastable properties of defects may provide more insight into the structure of the defects as well on the accuracy and applicability of the models. On a more futuristic note, these defects may in future serve as memory elements.

Since the detection of metastability requires careful analysis of data under very specific conditions, it is a property that is often overlooked during studies. In the talk, a general overview of the characterization of metastable defects by means of DLTS and C-T measurements will be given. Specific attention will be given to the details of the technique and the assumptions made during the measurements. The most common mechanisms underlying these metastable defects are charge state controlled metastability and negative-U. The experimental observation and analysis of these mechanisms will be discussed on the basis of some examples.