Electron Spin Resonance In Amorphous and Microcrystalline Silicon

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Semiconductors are a very important part of today's technological society. With more and more technological advances there is an increased need to improve the efficiencies of semiconductors. Amorphous and microcrystalline silicon are very important semiconductors used in a variety of electronic devices such as solar cells. Both materials are inexpensive to manufacture, but microcrystalline silicon may, in principle, possess better electronic properties.

An electron spin resonance (ESR) spectrometer is used to look at the behavior of unpaired electrons in a material. Details seen in the resulting spectra provide information about the defects in the material. In amorphous and microcrystalline silicon at room temperature, the defects observed are silicon dangling bonds. During the growth of the material, some atoms are placed with an insufficient number of bonds to surrounding atoms. These unsatisfied bonds have extra electrons that are paramagnetic. The more dangling bonds in amorphous or microcrystalline silicon, the less effective the material will be as a semiconductor. In addition the number of dangling bonds may increase the longer the material is

At room temperature the amorphous and microcrystalline silicon produce very weak signals on an ESR spectrometer. When the sample is cooled to low temperatures the intensity of the signal increases allowing the structure of the signal to be seen more clearly. Also, the low temperature results may show some additional structure not visible at room temperature. In preliminary experiments preformed on microcrystalline silicon at low temperatures we have seen a strong signal that changes slightly during irradiation with laser light. This result indicates the presence of additional paramagnetic defects induced by the optical excitation at low temperatures.