**Investigation Of The Mechanism Of Electrical Conduction Of Porous Silicon In Nitrogen Dioxide Atmosphere**

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The high sensitivity of non-impregnated Porous Silicon from heavily doped, p-type substrates has been demonstrated to occur in $NO_2$ atmosphere by electrical conductance measurements (1). A conductance increase of about two orders of magnitude in presence of 200 ppb at room temperature has been observed (2). Moreover, it has been reported in the past that the interaction with $NO_2$ is able to reactivate original acceptors present in the PS skeleton (3) giving rise to an intense free carrier (holes) absorption in the IR (4).

We investigated the interaction between $NO_2$ molecules and meso-PS skeleton by combining Fourier Transform Infra Red Spectroscopy (FTIR) and electrical characterization. In this way we found that the raise of electrical conductivity is mostly related to the carrier release, suggesting reactivation of original B impurities as the main mechanism for conductivity recovering. A linear dependence is found for $NO_2$ partial pressures above $10^{-3}$ Torr (Fig. 1). With further increase of the $NO_2$ partial pressure the concentration of released carriers tends to saturate to a value corresponding to the original acceptor density. Of course, the electrical conductivity does not reach the original value for the crystalline substrate, as a consequence for the reduced mobility of carriers inside the Si network. Nevertheless, a mobility value for holes of the order of units $cm^2V^{-1}s^{-1}$ has been estimated, several orders of magnitude higher than the value measured in vacuum.

For this reason, we believe that in the low pressure range ($10^{-5}$ to $10^{-3}$ Torr), not only the number of free carriers, but also their mobility is increased. We observe that in this range the conductivity does not follow a linear dependence with the free carrier concentration (Fig. 1). This suggests a transition from a trap-limited mechanism to a conduction via extended states. Traps deeply affect the electrical properties of PS because of its nanostructured and percolated nature. In principle, one trap solely is able to block one percolative pathway inside the material. Our results indicate that a fraction of released carriers does not participate to the conduction mechanism, but serves to saturate the traps present in the material opening in this way the pathways for electrical conduction.

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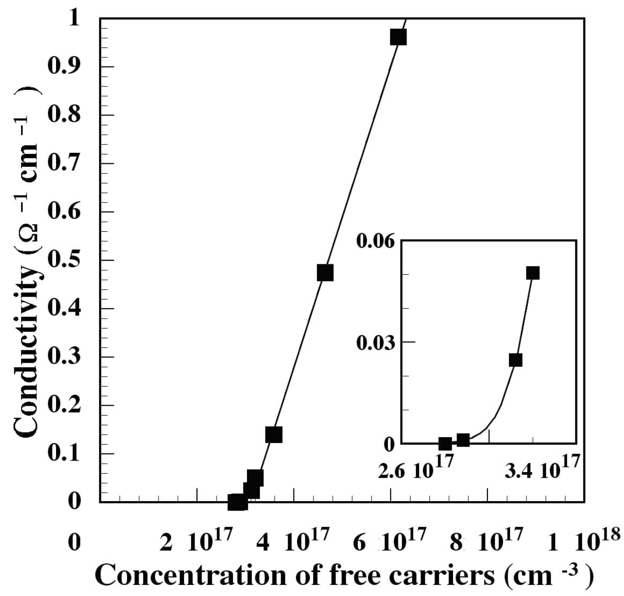


Fig. 1 Variation of electrical conductivity on the free carriers density obtained at various values of $NO_2$ partial pressure, by conductivity and FTIR measurements, respectively. The insert is a magnification of the low pressure regime.