THICKNESS AND TEMPERATURE DEPENDENCE OF THE AC ELECTRICAL CONDUCTIVITY OF POROUS SILICON THIN FILMS

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Porous silicon (PS) is a material with many interesting applications, due to its interesting properties related to its nanocrystalline nature. In order to investigate the influence of the thin film thickness on the electrical properties of PS, AC Impedance Spectroscopy measurements were performed in the temperature range from 200K to 350K. Samples investigated were of three different thick-nesses, namely 5, 20 and 40μm. The PS thin films were obtained on p-type Silicon wafers with a resistivity of 1-10 Ω.cm and the porosity was ~60%. The AC electrical conductivity measurements were performed from 1Hz to 1MHz in the voltage range of 0.5V to 3.0V. The samples under investigation were in MIS (Metal-Insulator-Semiconductor) geometry, the insulator being PS and the metal Al. They were kept in a cryostat under a reduced Helium atmosphere.

Figure 1 shows the frequency dependence of the real part of AC conductivity as a function of temperature in a logσ' vs logf presentation for a thin film 20μm thick. Note that, above a temperature dependent threshold frequency $f_c(T)$, marked by arrows, the AC conductivity is almost temperature independent on an exponential scale and rises steeply with frequency. The slope of this part equals to ~1.7. This abrupt increase with frequency is commonly attributed to contact resistance effects [1]. Below $f_c(T)$ the frequency dependence of the conductivity data is much weaker and can be approximated by a power law, but with much smaller exponents. The same results were also observed in all measured samples with thickness of 5 and 40 μm respectively.

The real part σ´ as a function of frequency is depicted in fig. 2 for different applied voltages. It is obvious that σ´ is independent of the voltage, implying that the conduction mechanism is linear [2]. The same results were also observed in all measured samples of thickness of 20 and 40 μm in all measured temperatures.

Figure 3 shows the frequency dependence of σ´ as a function of PS thickness. The differences in PS conductivity are related to contact resistances and are under consideration.

[1] R.A. Street et al J. Non.-Cryst. Solids, **5**,276, (1971)
[2] M. Theodoropoulou et al Mat. Sc. Eng. B (in pr)

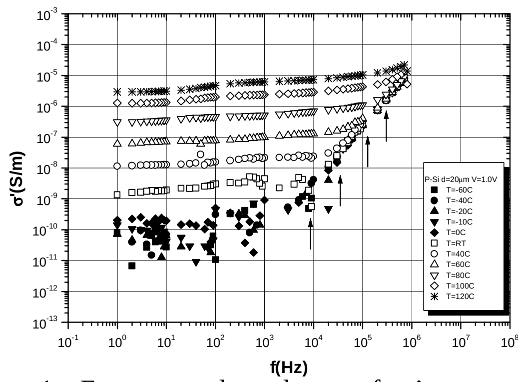

Figure 1: Frequency dependence of σ' as a function of temperature for V_{app}=1.0 V for PS thin films of 20μm thick.

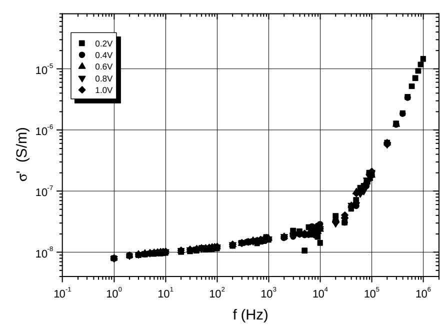

Figure 2: Frequency dependence of σ' as a function of the applied voltage at room temperature for a thin film 5μm thick.

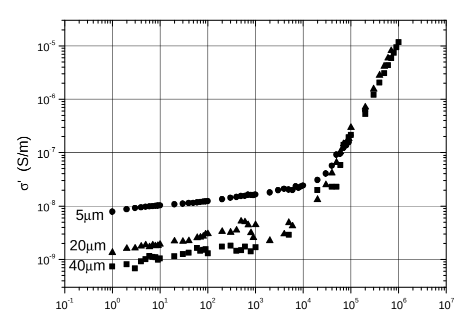

Figure 3: Frequency dependence of σ' as a function of film thickness for V_{app} = 1V at room temperature