frequency and 100K – 400K temperature range in the laboratory of “Condensed Matter Physics F5” at JSI. Determination of characteristic parameters of neutron-irradiation and neutron flux has been conducted with the methodolgy known from literature. Nano SiO_2 powder being pressed at $7kN/cm^2$ pressure in special conditions in the laboratory of “Thin Films and Surfaces F3” at JSI, was made in the form of tablet with 550 µm height and 5.5mm diameter and then placed in aluminium container appropriate to the channels of the reactor. The prepared samples have been continuously irradiated at central channel for 5, 10, 15 and 20 hours. Activity of the samples has increased up to 1,5GBq under neutron flux influence. Therefore all the measurements have been carried out approximately 200 hours after neutron flux influence. After irradiation silver contacts have been fixed on the surface of samples in special condition and examined its quality. It has been used Cr/Au electrodes obtained on the top layer by spray method. Then the obtained samples have been placed in between two platinum plates and measurements taken. Permittivity of the samples has been measured in “Novocontrol Alpha High Resolution Dielectric Analyzer” device at alternative current (AC ~0,5V) at 100-400 K temperature range. During the measurements storage accuracy of temperature in any degree was up to 0,01K and the accuracy was obtained with the method of bridge. From the experiments it has been measured the capacity and resistance of the samples and taking into account the known parameters of the samples, the permittivity has been calculated. All of the results obtained compatible with calculated values have been graphically depicted in “OriginPro 9.0” program.

3. Result and Discussions

At present work, within the measurements the frequency dependencies of dielectric properties of the samples have been reviewed at 4 different constant values of temperature. The experiments have been carried out within the range of 0,09 – 2260000 Hz at 95 different constant values of frequency and during the measurements it has been revealed that at various values of temperature the frequency dependency of dielectric constant are different. It has been reviewed the frequency dependence of the dielectric constant at 100K, 200K, 300K and 400K constant values of temperature. Firstly it has been reviewed frequency dependencies of dielectric constant at 100K and 200K temperature ranges (Fig. 1). At 100K value of temperature from $f(\varepsilon) = f(\nu)$ dependency it is obviously observed an increase of dielectric constant with increase of influence period of neutron flux. The dielectric constant of the initial sample to be minimum gives ground to say that the polarization in this case also is minimum. Under neutron flux influence extra charge carriers appear in the samples, so they cause extra general polarization in the samples.

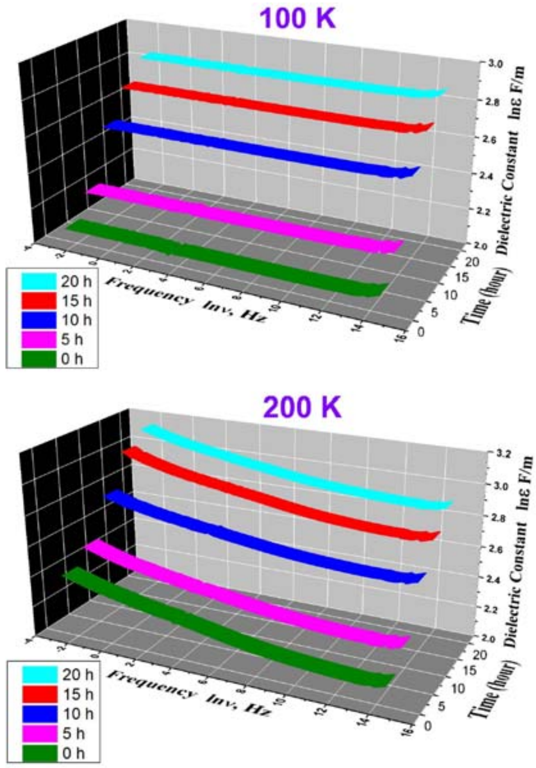

Figure 1: Dielectric constant and frequency dependencies of silica nanoparticles at 100K and 200K temperatures (0h – before irradaition, 5h, 10h, 15h and 20h – after irradiation).

In the result of these charge carriers the dielectric constant increases. The similar process occurs at 200K value of temperature. In this temperature decrease of dielectric constant with frequency increase is the result of combined effects of temperature and frequency [19]. At 100K temperature the chaotization existing in frequency dependence of the electric conductivity is maybe due to the clusters formed in the system at this temperature [19, 32-40]. At the same time that chaotization is observed in a certain degree at 200K value of temperature as well [19].

On the other side the chaotization to be more at low frequency range is due to the nanomaterial to be more inclined to polarization at this range [19]. At relatively high temperatures it is observed more obviously especially in the samples exposed to neutron flux influence (Fig. 2). As it seem from figure, at 300K and 400K values of temperature the dielectric constant gets its maximum values at low frequencies. This maximum is observed more sharply in the samples exposed to neutron flux influence at 300K temperature. The obtained results can be accepetd as formation of nanoparticles in dipole stae at low frequencies [19, 41].

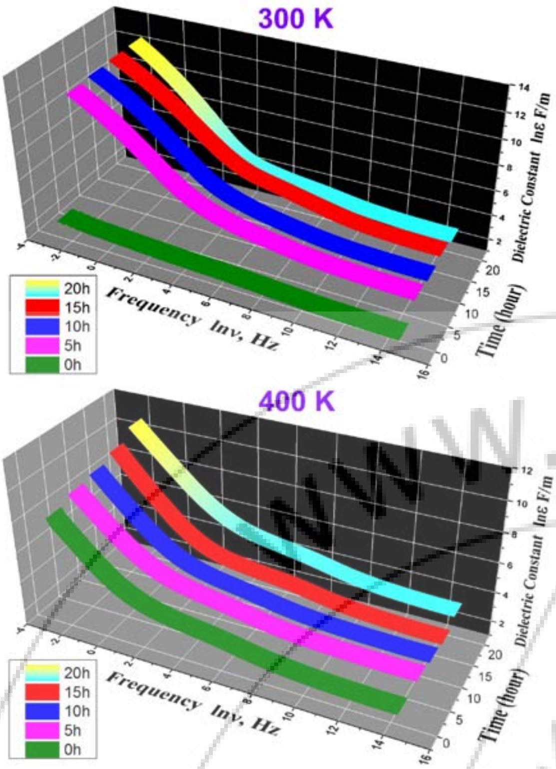

Figure 2: Dielectric constant and frequency dependencies of silica nanoparticles at 100K and 200K temperatures (0h – before irradaition, 5h, 10h, 15h and 20h – after irradiation).

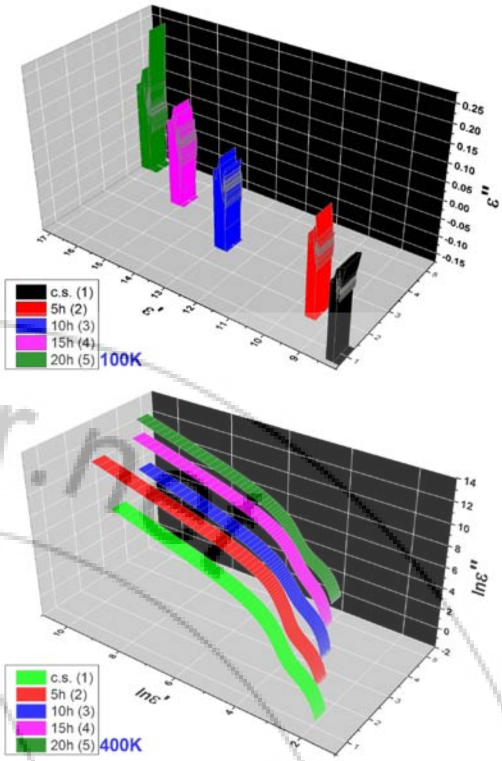

Figure 3: Mutual dependence of dielectric constant of silica nanoparticles

At 100K value of temperature the fact of increase of the dielectric constant with increase of neutron flux is confirmed once again from complex dependence of the real and imaginary parts of permittivity at 100 K and 400 K (Fig. 3, c.s. – before irradaition, 5h, 10h, 15h and 20h – after irradiation). On the other hand it is observed oscillation of dielectric constant around zero value of imaginary part. At low temperatures the clusters being formed inside the sample decompose under frequency influence and cause the device to detect negative resistance [19]. This state has been observed also during analysing the electric conductivity of the samples and explained by similar cluster model [19, 32-40]. At 400K temperature the existing clusters are destructed under the influence of frequency and heat and there are no negative cases in imaginary part of permittivity. At this temperature at the range of about 0,15 – 0,25 values of imaginary part of permittivity it is observed the cases similar to "Cole-Cole" diagram at average frequency range, and it indicates to the existence of polarization which can be relaxed at that range. In this case the calculated relaxation period decreases directly proportional to irradiation period and the values are compatible with the polarization of nano particles.

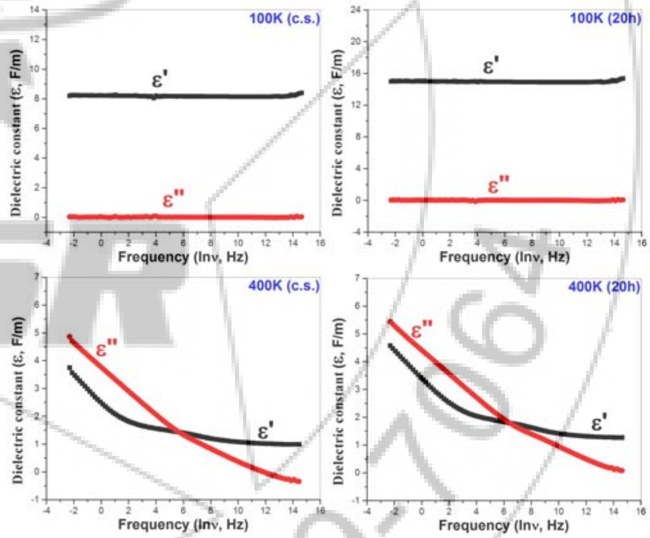

Figure 4: Real and imaginary parts of dielectric constant and frequency dependencies of silica nanoparticles.

It can be argued that extra charge carriers are formed in the system with irradiation influence and it reduces the relaxation period. At 400 K temperature in each curve it is observed two states similar to "Cole-Cole" diagram. It allows to say that at this temperature there may be two types of relaxors different for their stationar states [19]. From the dependencies of real and imaginary parts of dielectric constant on frequency on a same coordinate system, it is obviously seen that at 100 temperature the real part is several times more than the imaginary part (Fig. 4). On the other hand though there is no considerable change in the imaginary part of dielectric constant in the samples exposed to neutron flux influence for 20 hours, the real part of dielectric constant has increased approximately 2 times.

Also, at 100K value of temperature the real and imaginary parts of dielectric constant almost are not dependent on the frequency. At 400K temperature at low frequencies the imaginary part of dielectric constant is larger than the real one, but in contrast at high frequencies it is less. It is usually taken as dancing presence of charge carriers, accumulation of charges and charging-discharging current inside the sample [42,43]. In this case the existence of dancing-proton conductivity inside nano SiO_2 is expected [42, 43]. It has been revealed from the conducted analyses that the numerical values of the real and imaginary parts of dielectric constant increase with temperature increase.

4. Conclusion

In the result of the conducted researches it has been revealed that under neutron flux influence the dielectric constant of nano silica increases in general tendency. At 100K value of temperature the dielectric constant increases with increase of neutron flux influence period regardless of frequency. It has been revealed that the dielectric constant depend on frequency inversely proportionally at relatively high temperature (400K). After neutron flux influence the increase in dielectric constant is more severe at low frequencies. From complex dependences of real and imaginary parts of dielectric constant of nanoparticles it has been revealed that the clusters formed at 100K temperature induce the device to show dielectric loss as negative value. At other temperatures (400K) from the cases similar to Cole-Cole diagrams it has been revealed that the value of relaxation period is compatible with the polarization of nano particles.

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