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Calculations of Electrets Property of Single Human Renal Stones at Regular Interval of Removing Minerals Compositions

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Abstract

In the modern science and technology the electrical and thermal conductivity studies of renal stone plays an impotent role to understand the natural formation. The free electrons act as carriers to carry their energy. In the present investigations, three renal stones are collected poor hard working male who was affected with mineral deposition in the urinary tracts in a periodic collection within three years. The stones are collected from the hospital by Lithotropic treatment process. Electrical, thermal conductivities are measured at different temperatures and calculated temperature coefficients of the renal stones.

***Key words**: Renal stones, minerals, Process instrumentation, Bio-chemical, electron exchange and energy transfer.*

1. INTRODUCTION

The conductivity of biomaterials, bio-minerals has been reported by the author [1]. The technical concepts such as thrombogenesis and enzymatic activity of cytochrome oxides have been dealt with either semi conductivity or electrets behavior of different bio-minerals. In the present research, both these aspects have been considered and make attempted on the same materials, namely renal stones or renal calculi. Investigation of electrets behaviors and conductivity becomes important and essential to find to inhibit the renal stones or prevention. The electrets behavioral of the renal stone material were studied through TSD, TSP [2-4]. Here the author report the D.C conductivity of renal stones as a function of temperature and applied electric field and its relations are studied.

2. MATERIALS AND METHODS

Kidney stones are removed from the affected patient continuously for a period of three years by Lithotropic process in the Rasi stones diagnosing center in Rasipuram, Namakkal, India. The three stone constituents are analyzed by bio-chemical analysis process. The renal stone constituent's presences are reported in Table 1. The major constituents of the samples are calcium phosphate and its oxalate ions bonded to an organic and sulponated muscoproteins [5]. The investigation results on TSP, TSD are reproducible from stone to stone. Due to the lengthy process of research, only three samples are used in a single person (Figures 1-3).

Table 1. Chemical composition present in the renal stones.

Stones	***Presence of Chemical constituents***
1	Calcium, silica-chromium, phosphate with hydrogen oxalate group.
2	Calcium oxalate, mono silica, di-hydrate with phosphate and chromium.
3	Calcium oxalate with silica chromium (major) monohydrate with Phosphates.

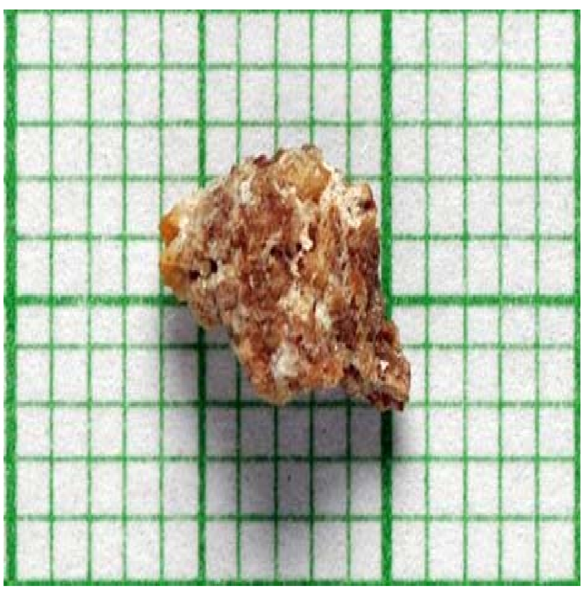

Figure 1. Stone-1.

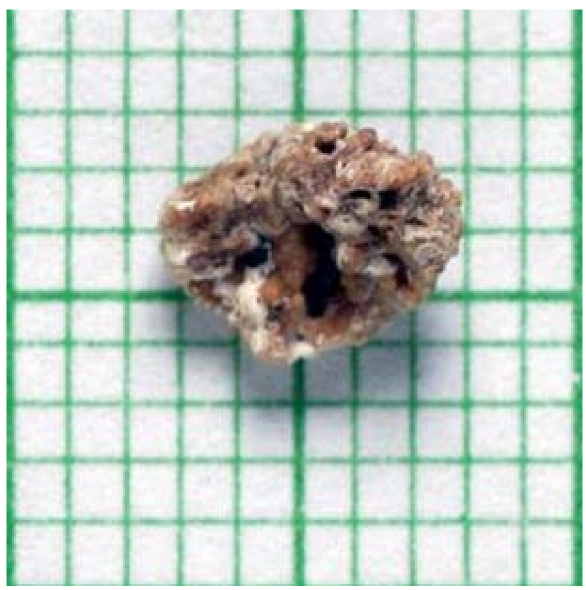

Figure 2. Stone-2.

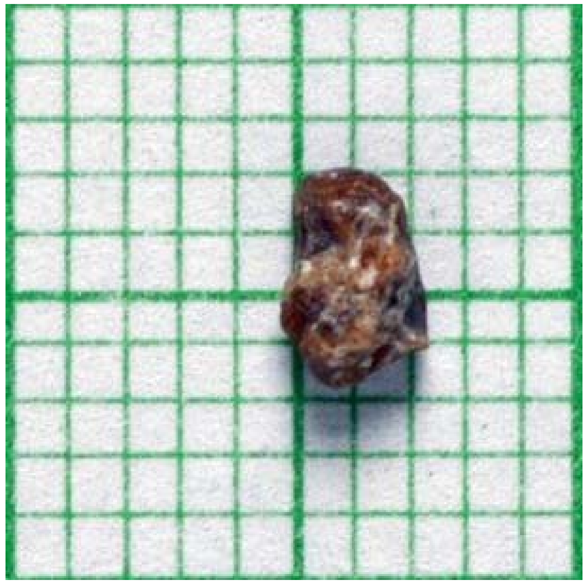

Figure 3. Stone-3.

Stone samples are initially removed in the bloodstains and other impurities from the surfaces of the sample and dried naturally. Then the renal stone sample surfaces are smoothened by using very thin grain artificial grinder. The renal stone samples are placed in the probes with in contact. The full set up are kept inside the micro oven, which is automatically heated with monitor and controller (the accuracy is $2^{o}C$). The D.C conductivity is studied at the temperature (T) from 300 K to 370 K at a desired temperature. The electric field varied from 2 Volts to 16 Volts and the corresponding current flows are measured. The all the three renal stone are kept in hot Owen at a particular temperature at least 20 minutes to reach the entire heat distribution. The current flow of the renal stones mainly depends upon the presence of the carriers in a samples according to the Curie-Von-Schweidlar law. The conductivity has been reported for polymer samples [6-8] and ionic materials also [9-10].

The physical parameters of the renal stones are measured by conventional methods. The temperatures are varied from 300 K to 370 K. The applied voltage (V), corresponding current measurements (I), resistance (R), resistivity (ρ), conductivity (σ) and current density (J) of each sample at a particular temperature are reported in Tables 2 to 15.

Table 2. Electrets properties of renal stone A at 30^{o}C, A=20x10^{-6} m^{2}, L=5x10^{-3}m.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^{6} (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) Amp/m^{2}
1	2	4	0.500	2000	0.200
2	4	8	0.500	2000	0.400
3	6	12	0.500	2000	0.600
4	8	16	0.500	2000	0.800
5	10	18	0.550	2200	0.900
6	12	19	0.632	2528	0.950
7	14	20	0.700	2800	1.000
8	16	22	0.727	2908	1.100
Average values			0.576	2305	0.625

Co efficient of electrical conductivity (σ) = 4.4338x10^{-4} mho.m-1

Table 3. Electrets properties of renal stone A at 50^{o}C, A=20x10^{-6} m^{2}, L=5x10^{-3}m.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^{6} (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) Amp/m^{2}
1	2	6	0.333	1332	0.300
2	4	10	0.400	1600	0.500
3	6	12	0.500	2000	0.600
4	8	16	0.500	2000	0.800
5	10	20	0.500	2000	1.000
6	12	24	0.500	2000	1.200
7	14	28	0.500	2000	1.400
8	16	29	0.552	2208	1.450
Average values			0.473	1893	0.906

Co efficient of electrical conductivity (σ) = 5.2826x10^{-4} mho.m-1

Table 4. Electrets properties of renal stone A at 75°C, $A=20x10^{-6}$ m^2, $L=5x10^{-3}$m.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^6 (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) Amp/m^2
1	2	7	0.286	1144	0.350
2	4	12	0.333	1332	0.600
3	6	16	0.375	1500	0.800
4	8	19	0.421	1684	0.950
5	10	23	0.434	1736	1.150
6	12	26	0.462	1848	1.300
7	14	29	0.480	1932	1.450
8	16	32	0.500	2000	1.600
Average values			0.358	1430	0.844

Co efficient of electrical conductivity (σ) = $6.8965x10^{-4}$ mho.m-1

Table 5. Electrets properties of renal stone A at 95°C, $A=20x10^{-6}$ m^2, $L=5x10^{-3}$m.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^6 (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) Amp/m^2
1	2	10	0.2	800	0.500
2	4	14	0.286	1144	0.700
3	6	18	0.333	1332	0.900
4	8	22	0.364	1456	1.100
5	10	26	0.385	1540	1.300
6	12	30	0.400	1600	1.500
7	14	34	0.412	1648	1.700
8	16	38	0.421	1684	1.900
Average values			0.350	1401	1.013

Co efficient of electrical conductivity (σ) = $7.1378x10^{-4}$ mho.m-1

Table 6. Electrets properties of renal stone B at 33°C, A=30x10^{-6} m^2, L=5x10^{-3}m.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^6 (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) Amp/m^2
1	2	6	0.333	1650	0.200
2	4	8	0.500	2500	0.267
3	6	11	0.545	2755	0.367
4	8	14	0.571	2855	0.467
5	10	15	0.667	3335	0.500
6	12	16	0.750	3750	0.533
7	14	18	0.778	3890	0.600
8	16	20	0.800	4000	0.667
Average values			0.618	3088	0.450

Co efficient of electrical conductivity (σ) = 3.2383x10^{-4} mho.m-1

Table 7. Electrets properties of renal stone B at 51°C, A=30x10^{-6} m^2, L=6x10^{-3}m.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^6 (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) Amp/m^2
1	2	8	0.250	1250	0.267
2	4	12	0.333	1665	0.400
3	6	14	0.429	2145	0.467
4	8	15	0.533	2665	0.500
5	10	16	0.625	3125	0.533
6	12	19	0.632	3160	0.633
7	14	20	0.700	3500	0.667
8	16	22	0.727	3635	0.733
Average values			0.528	2643	0.525

Co efficient of electrical conductivity (σ) = 3.7835x10^{-4} mho.m-1

Table 8. Electrets properties of renal stone B at 74°C, $A=30x10^{-6}$ m^2, $L=6x10^{-3}$m.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^6 (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) Amp/m^2
1	2	12	0.167	835	0.400
2	4	14	0.286	1430	0.467
3	6	16	0.375	1875	0.533
4	8	18	0.444	2200	0.600
5	10	20	0.500	2500	0.667
6	12	24	0.500	2500	0.800
7	14	26	0.538	2690	0.867
8	16	29	0.552	2760	0.967
Average values			0.420	2099	0.663

Co efficient of electrical conductivity (σ) = $4.764x10^{-4}$ mho.m-1

Table 9. Electrets properties of renal stone B at 98°C, $A=30x10^{-6}$ m^2, $L=6x10^{-3}$m.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^6 (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) x 10^{-4} Amp/m^2
1	2	14	0.143	715	0.467
2	4	18	0.222	1110	0.600
3	6	19	0.316	1580	0.633
4	8	21	0.381	1905	0.700
5	10	24	0.417	2085	0.800
6	12	28	0.426	2130	0.933
7	14	32	0.438	2190	1.070
8	16	35	0.457	2285	1.167
Average values			0.350	1750	0.7963

Co efficient of electrical conductivity (σ) = $5.714x10^{-4}$ mho.m-1

Table 10. Electrets properties of renal stone C at 31°C, $A=8x10^{-6}\ m^2$, $L=2x10^{-3}m$.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^6 (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) x 10^{-4} Amp/m^2
1	2	3	0.667	2668	0.376
2	4	5	0.800	3200	0.625
3	6	6	1.000	4000	0.750
4	8	8	1.000	4000	1.000
5	10	10	1.000	4000	1.250
6	12	12	1.000	4000	1.500
7	14	14	1.000	4000	1.750
8	16	16	1.000	4000	2.000
Average values			0.933	3734	1.156

Co efficient of electrical conductivity (σ) = $2.6780x10^{-4}$ mho.m-1

Table 11. Electrets properties of renal stone C at 48°C, $A=8x10^{-6}\ m^2$, $L=2x10^{-3}m$.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^6 (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) x 10^{-4} Amp/m^2
1	2	5	0.400	1600	0.625
2	4	7	0.571	2284	0.875
3	6	9	0.667	2668	1.125
4	8	13	0.667	2668	1.625
5	10	15	0.667	2668	1.875
6	12	18	0.667	2668	2.250
7	14	19	0.737	2948	2.375
8	16	20	0.800	3200	2.500
Average values			0.647	3337	1.656

Co efficient of electrical conductivity (σ) = $2.9967x10^{-4}$ mho.m-1

Table 12. Electrets properties of renal stone C at 76°C, $A=8x10^{-6}$ m^2, $L=2x10^{-3}$m.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^6 (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) x 10^{-4} Amp/m^2
1	2	6	0.333	1332	0.750
2	4	9	0.444	1776	1.125
3	6	12	0.500	2000	1.500
4	8	13	0.615	2460	1.625
5	10	16	0.625	2500	2.000
6	12	18	0.667	2668	2.250
7	14	21	0.667	2668	2.625
8	16	24	0.667	2668	3.000
Average values			0.565	2259	1.859

Co efficient of electrical conductivity (σ) = $4.4267x10^{-4}$ mho.m-1

Table 13. Electrets properties of renal stone C at 93°C, $A=8x10^{-6}$ m^2, $L=2x10^{-3}$m.

S. NO	Voltage applied in Volts (V).	Current measured in micro -amperes (I).	Resistance 10^6 (Ohm).	Resistivity in Ohm. m (ρ).	Current density (J) x 10^{-4} Amp/m^2
1	2	10	0.200	800	1.250
2	4	12	0.333	1332	1.500
3	6	16	0.375	1500	2.000
4	8	18	0.444	1776	2.250
5	10	19	0.526	2104	2.375
6	12	21	0.571	2284	2.625
7	14	24	0.583	2332	3.000
8	16	27	0.593	2372	3.375
Average values			0.453	1813	2.297

Co efficient of electrical conductivity (σ) = $5.5157x10^{-4}$ mho.m-1

Table 14. Electrical parameters of renal stone samples.

S. No	Stones	Temperature in degree Celsius	R in 10^6 ohms	ρ Ohm-meter	J x10^{-4} Ampere/met^2
1	A	30	0.576	2305	0.625
		50	0.473	1893	0.906
		75	0.358	1430	0.844
		95	0.350	1401	1.013
2	B	32	0.618	3088	0.450
		51	0.528	2643	0.525
		74	0.420	2099	0.663
		98	0.350	1750	0.7963
3	C	31	0.933	3734	1.156
		48	0.647	3337	1.656
		76	0.565	2259	1.859
		97	0.453	1813	2.297

Table 15. Thermal conductivity of renal stones at different temperature.

S. No	Name of the (Stone) samples	Conductivity (σ) X10^{-4} mho.m-1	Temperature in degree Celsius	Thermal conductivity $K= \sigma L_z T$ X10^{-10} W/mc
1	A	4.4338	30	1.4898
		5.2826	50	2.9583
		6.8965	75	5.7931
		7.1378	95	7.5941
2	B	3.2383	32	1.1606
		3.7835	51	2.1611
		4.7640	74	3.9484
		5.7140	98	6.2717
3	C	2.6780	31	0.9298
		2.9967	48	1.6110
		4.4267	76	4.1044
		5.5157	97	6.5272

One can unable to measure the hall coefficient of the renal stones. The stones containing collagens like micro-protein and apatite also have some organic matrix like protein at 5% of the total weight [13]. The protein matrix is clearly visible under a scanning microscope. The D.C electrical conductivity of the renal stones are compared and calculated with the standard ionic conductors [11] and semiconductors [12].

The ionic conduction for the renal stone is:

$$\sigma=\sigma_1\exp^{(A/KT)}+\sigma_2\exp^{(-B/KT)}$$

Where σ_1,σ_2 are the zero field conductivity, A and B are constants. The two exponential terms are nature of normal conductors.

In semiconductors the conductivity,

$$\sigma=\sigma_0\exp^{(-Eg/2KT)}$$

Here σ_0 is the zero field conductivity and Eg is the activation energy of the conductors at a particular temperature (T). Because of practical inconvenience of electron microscope (SEM), a fine powder of kidney stone was observed under a high resolution optical microscope and shows fibrils of protein. Thus renal stones can be regarded as a mixture of semi conducting materials like N type and P type, but totally it behaves like N type material or conductors. Hence, conductivity of a kidney stone shows it may be interpreted in terms of a partially compensated semiconductor. Available mechanism for conduction of renal stones may be sought with the help of various scattering mechanism of conductors and semiconductors [14]. The conductivity of samples depends upon the scattering by lattice vibrations. In conductor the curve between conductivity and temperature should be straight line, but in semiconductor, it is not in usual [15].

The TSP, TSD data of kidney stones also give added information about its conduction mechanism [2, 3]. For the TSP, TSD conductivity of a sample, the changing current is composed of three components, which are conduction, polarization and depolarization. When temperature increases, the conductivity of a samples is increased, the polarization and depolarization peaks merge in the conduction current or only a part of it is observable [16]. The voltage dependence of conductivity decreases with rise of temperature (T). The current density decreases, which shows the conduction is in non-ohmic. This change suggests a warm electron effect [17]. At higher temperature, the current density is directly proportional to voltage and gives the ohmic behaviors. This is clear that for a sample at higher temperature, the thermal energy difference between the charge carriers and lattices are relatively low or due to asymmetric effect [18] formed in inside the crystals of calcium oxalates and calcium phosphates.

3. CONCLUSION

For all the three renal stone samples, thermal conductivity and electrical conductivity are calculated. At higher temperature, the thermal conductivity of all the samples is increased and the electrical conductivity changed. The entire samples are high conductivity at low temperature, but when the temperature increases, the conductivity decreases.

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