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IRREGULARITY AND SYMMETRY IN THE ELECTROGRAPHIC IMAGES

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Abstract
The semi-quantitative analysis of some electrographic images was carried out. Ionic solutions simulating biological aqueous media have been investigated. Comparative data by means of fractal dimension have been discussed.
Keywords: alkaline metal chloride, electric discharges, box-counting algorithm

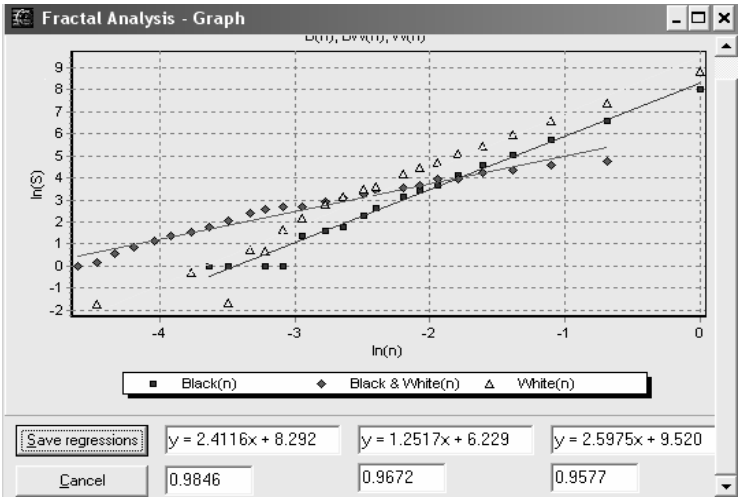
1.Introduction

Electrical discharges are ubiquitous in atmosphere due to the natural cloud dipoles interaction or to the artificial sources of electrical power (especially energy transmission lines). The corona discharge is transitory non-thermal plasma generated in open atmosphere between a thin electrode and a plate one when connected to a direct current source. Corona discharge is difficult to detect because it emits very weak radiation, mostly in the UV band (at night it is barely visible to the naked eye, though it can be imaged by UV sensitive devices). The electron and ion flows from the discharge space can interact with atoms and molecules from the surrounding medium generating free radicals and, further, various peroxides. These last ones can seriously affect living tissues, so that, the corona discharge need to be considered also for biomedical applications. Among the applications of the corona discharge interaction with different media we need to mention: the microorganism destruction, the visualization of the human energy field and the investigation of aqueous solutions similar to biological ionic media [1-3].

2. Materials and methods

Electronic device able to generate direct current pulses with controlled amplitude, duration and polarity was designed and assembled in our laboratory. Photosensitive support

(paper and film) was used to record the electrographic images obtained following the interaction of the corona discharge with aqueous ionic solution droplets. Ionic solutions 1 M (NaCl, KCl, $CoCl_2$) freshly prepared in distilled water have been investigated. Twenty recordings for every solution have been done. Specialized soft (commercially available) for the fractal analysis, working on the basis of box-counting algorithm was utilized.



Df = logN / log(L/l)

Fig. 1. The display of HarFa soft

HarFa calculates the fractal dimension on the basis of the box-counting algorithm. Traditionally, box counting method works by laying meshes of different sizes r and then counting number of boxes N needed to cover tested object completely. Slope D of the linear portion of function **log N(r) = D(log(1/r)) + log k** is assumed to be box (fractal) dimension and its k intercept is the fractal measure. We can perform linear regression of the data set and determine Box-dimension and fractal measure.

3. Results and Discussions

In all three cases positive polarity was chosen, unique pulses have been applied, the pulse amplitude was equal to 15 kV and its duration was equal to 0.5 ms. Numerous streamers have been revealed with non-uniform disposition around the ionic solution drop whatever the metal ion was. The qualitative and semi-quantitative analysis of the electrographic image was accomplished by means of the fractal algorithm.

Some qualitative distinct features can be seen to a deeper visual investigation: (i) in the case of KCl solution (fig. 2) the blackening is the stronger and the streamer traces are grouped along a main branch; (ii) in the case of $CoCl_2$ solution (fig. 3), the streamer traces of the electrographic recording present radial symmetry in most of the cases;

Fig. 2. Ionic solution 1M of KCl

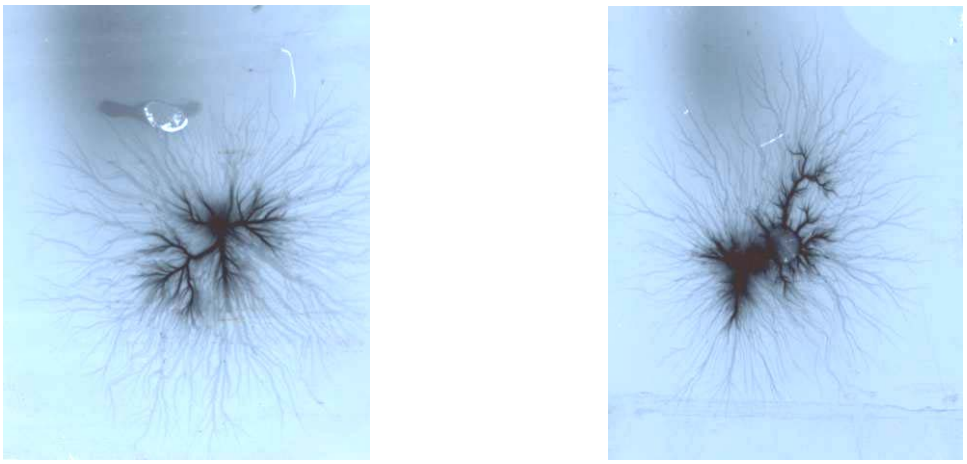


Fig. 3. Ionic solution 1M of $CoCl_2$

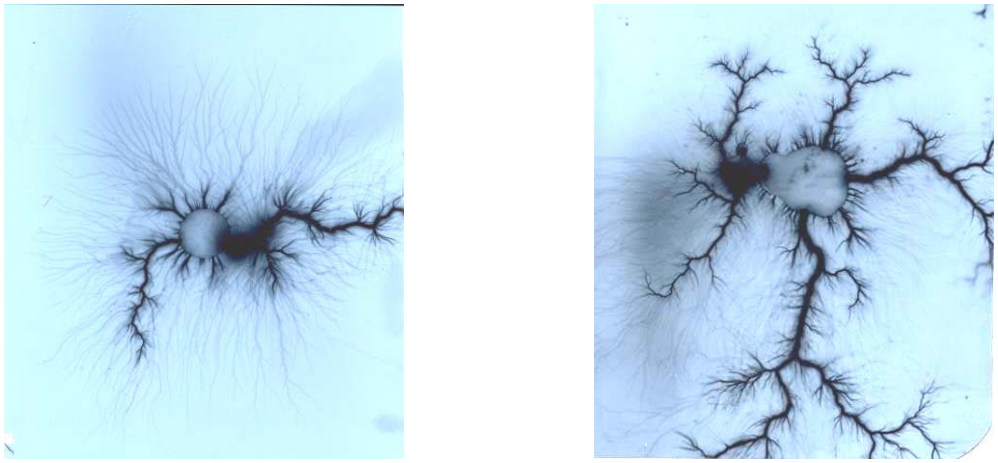


Fig. 4. Ionic solution 1M of NaCl

(iii) in the case of the NaCl solution (fig. 4) the main streamer presents numerous bifurcations (ramified patterns).

Na^+ and K^+ are usual components of biological liquids in contrast to the Co^{2+} ion – which is, however, biocompatible (such as in the case of water-ferrofluids based on iron and cobalt oxides). The graphic representation (fig. 5)of the fractal measure (Table I) versus the atomic number of the metal from the ionic solutions revealed the linear dependence.

Table. I. Fractal analysis of the electrographic images of the ionic solutions drops

fractal dimension	fractal measure	standard deviation	
1.6618	12.9340	0.9942	Na
1.6115	12.7148	0.9947	K
1.6326	12.6108	0.9946	Co

So, the complexity of the electrographic image is increasing to the increase of the atomic number of the metal ion from the chloride solution.

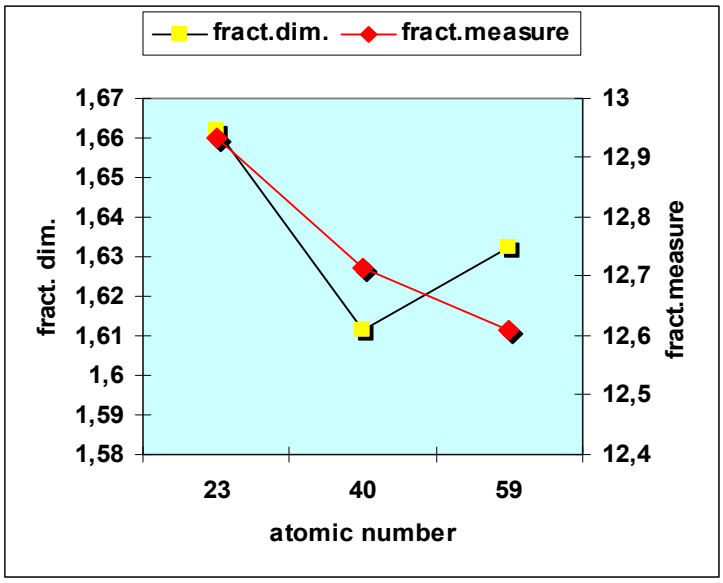


Fig. 5.The fractal dimension and fractal measure versus the atomic number

This study is related to the response to corona discharge of living bodies in the frame of the simplified modeling of the biological liquids as ionic aqueous solutions.

4. Conclusions

The interaction of corona discharge and aqueous solution of metal chlorides provided electrographic images with some peculiarities related to the nature of the metal ion. The fractal analysis could be used as a quantitative tool in the classification of the electrographic patterns generated following this interaction.

References

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