PHENOMENOLOGICAL STUDY OF LIESEGANG RINGS

Felipe T. Nakata[1*], Martina C. Reis[1]

[1]University of São Paulo, School of Engineering, Department of Chemical Engineering, São Paulo, Brazil
[*]nakatafelipe@usp.br

ABSTRACT

This work is based on the pre-nucleation model proposed by George et al. [1] to simulate the Liesegang rings phenomenon. There are only three chemical species, which are the outer electrolyte, the inner electrolyte, and the precipitate, and two reactions: precipitation and aggregation. The two electrolytes can diffuse through the gelatinous media, but the precipitate, once formed, stays still. The precipitation phase only occurs if the product of the two reactants is above a critical threshold, whereas the aggregation has an autocatalytic mechanism.

With respect to the three empirical laws — space, time, and width —, according to our simulation results: (i) the rings' position follow a geometric progression; (ii) the time of formation of each ring is proportional to the square of its position; (iii) the width is practically constant across each ring. The first two findings are in agreement with the results generally reported in literature, but the last one is not, and it is probably related to the increase of the average precipitate concentration observed from one ring to another.

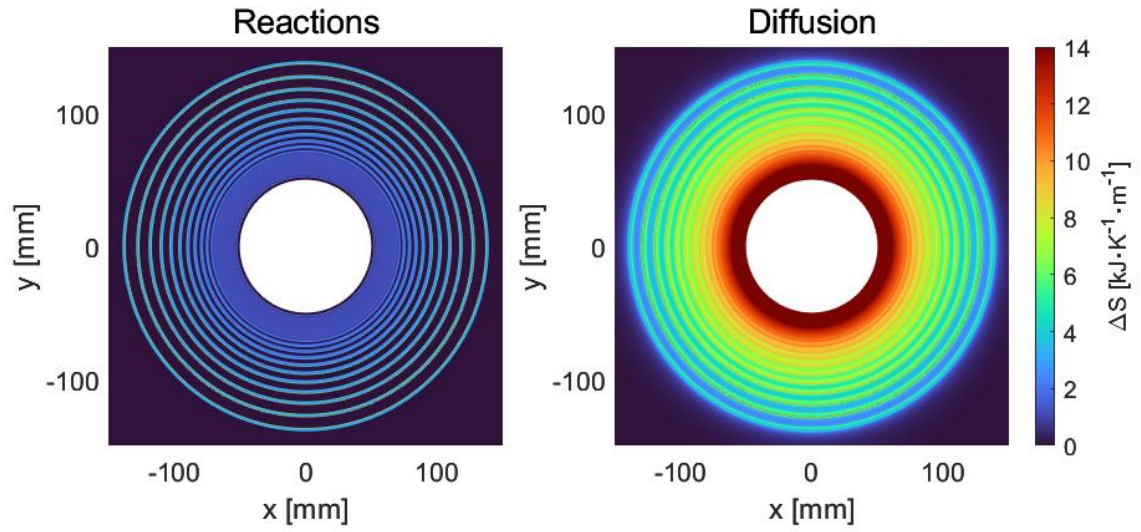

Figure 1. Total entropy production generated by reactions and diffusion processes at $t = 2 \times 10^6$ s. The internal radius is 50 mm, the concentration of the outer electrolyte is constant, at 0.5 M, while the initial concentration of the inner electrolyte is 0.05 M.

It was found that the diffusion is the main driving force for entropy generation. Most diffusion occurs because of the reduction of the concentration of the reagents at the region of the rings, which occurs due to the consumption by the reactions. By increasing the initial concentration of the inner (inside the gel) or the outer electrolyte (outside the gel), the spacing between the rings decreased, which agrees with the Matalon-Packter law. Finally, the findings of this work may be useful for better understanding self-organization chemical processes, especially when diffusive forces are significant within the considered time scales.

REFERENCES

[1] J. George, et al. Rhythmic pattern formations in gels and Matalon-Packter law: A fresh perspective (2003), Pramana - J Phys, 60, 1259.