Curvature effects on a phenomenological reaction-diffusion model of biodegradation

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The biodegradation process of some types of polymers occurs due to many different factors including their morphology, structure and chemical composition, etc. Although this is a complicated process, most of its important stages like the diffusion of monomers and the hydrolysis reactions have been modeled phenomenologically through reaction-diffusion equations, where the properties of the polymers were encompassed [1].

Using a reaction-diffusion model for the biodegradation of polymers [1], we study in this contribution the possible effects of the curvature of the system geometry in the degradation process, which is characterized by the interaction of the corresponding reaction rate and the diffusion coefficient.

It has been shown that the curvature of the system plays an important role in confined diffusion processes [2, 3] and instability criteria in pattern formation in reaction-diffusion systems [4, 5]. In particular the solution region changes due to the particular geometry of the problem.

To illustrate the problem of diffusion on a curved surface, we consider the so-called Gaussian bump [6]. We choose this surface because mathematically, its metric depends only on one variable so its analysis can be simplified. Physically contains positive and negative curvatures about its waist, and zero in the asymptotic limit.

We show how the curvature differences influences the relation between diffusion and reaction rate that moderates degradation.

References

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