Evaluation of Chemobrionic Structures using Different Types of Reactants

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BACKGROUND

- Chemobrionics are biomimetic complex structures that have different morphology, chemical composition and microstructure depending on the reactants, growth methods and environmental conditions [1].
- In this study, chemobrionic structures composed of different reactants including calcium, magnesium, zinc and chromium salts and silicate and carbonate anions were formed with the use of injection method and their growth pattern and microstructures were evaluated.
- Different growth regimes (jetting, budding) were observed which are highly dependent on the type of constituents. Obtained micrographs from SEM analysis shows that the textures of chemobrionics are clearly different for the different reactants and these microstructures are highly consistent with the literature. These differences in growth regime and morphologies could be due to the variations of reactivity, solubility and density of reactants.

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REFERENCES
[1] Barge, L. M., et al. 2015, Chemical Reviews, 115, 8652–8703.
[2]Cardoso S.S.S., Cartwright J.H.E., Sainz-Diaz C.I. Langmuir 2016, 32, 8748–8758
[3] Cartwright J.H.E., Escribano B., Sainz-Diaz C.I. Langmuir 2011, 27, 3286–3293
[4] Sainz-Diaz C.I., Escamilla-Roa E., Cartwright J.H.E. Geochemistry, Geophysics, Geosystems, 2018, 19, 2813–2822.

OBJECTIVES

- To evaluate the formation and growth pattern of chemobrionics grown with different metal salts-$CaCl_2$, $MgCl_2$, $ZnCl_2$, $CrCl_3$ and several cations-Na_2SiO_3 and Na_2CO_3.
- To study the microstructure of chemobrionics using SEM imaging
- To compare the growth regime, behaviour and morphology of different cations and anions in the formation of chemobrionic structures.

METHODS

Growth method	Injection
Concentration	0.5 M metal salt solution 2.0 M anionic solution
Flow rate	2.0 ml/h
pH	2.5 for metal salt solution 12.5 for anionic solution
Temperature	25 °C

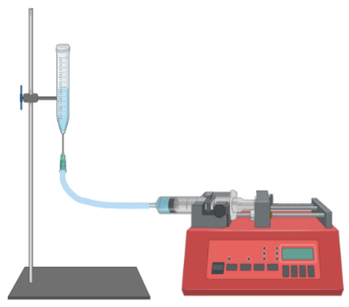

Figure 1. Experimental setup

RESULTS

- Calcium chloride – silicate/carbonate → Wider white tubular structure that grew as a cluster with several narrow tubes at the top surface of this cluster. (Figures 2a, e)
- Magnesium chloride – silicate → A narrow transparent tube was observed along the vessel and several buds were seen at random locations of structure. (Figure 2b)
- Magnesium chloride – carbonate → A short conical chemobrionic was formed instead of a long tube and the verticality of the structure grown with carbonate solution was smaller than in silicate case. (Figure 2f)
- Zinc chloride – silicate/carbonate → A large unstructured transparent envelope formed in a short time, it was dragged up with the fluid jet and accumulated at the air-liquid interface. (Figures 2c, g)
- Chromium chloride – silicate/carbonate → A straight green tube of about 1.0 mm in diameter formed in a jetting growth regime. These structure had a more resistant membrane so, they were removed from the reaction vessel more easily without rupture. (Figures 2d, h)

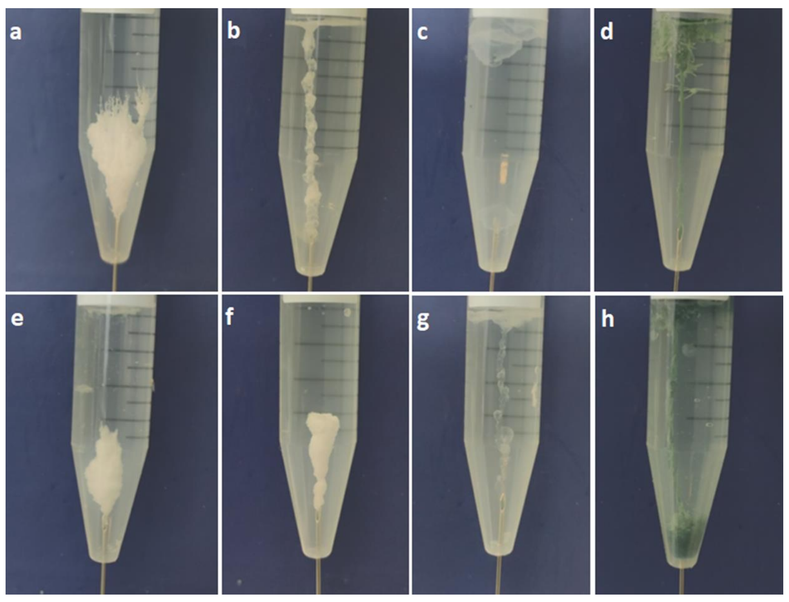

Figure 2. Growth pattern of chemobrionics; **a**. Ca-Si, **b**. Mg-Si, **c**.Zn-Si, **d**. Cr-Si, **e**. Ca-CO_3, **f**. Mg-CO_3, **g**. Zn-CO_3, **h**. Cr-CO_3.

- Obtained micrographs from SEM analysis shows that the textures of chemobrionics are clearly different for the different reactants and these microstructures are highly consistent with the literature (Figure 3) [2, 3, 4].

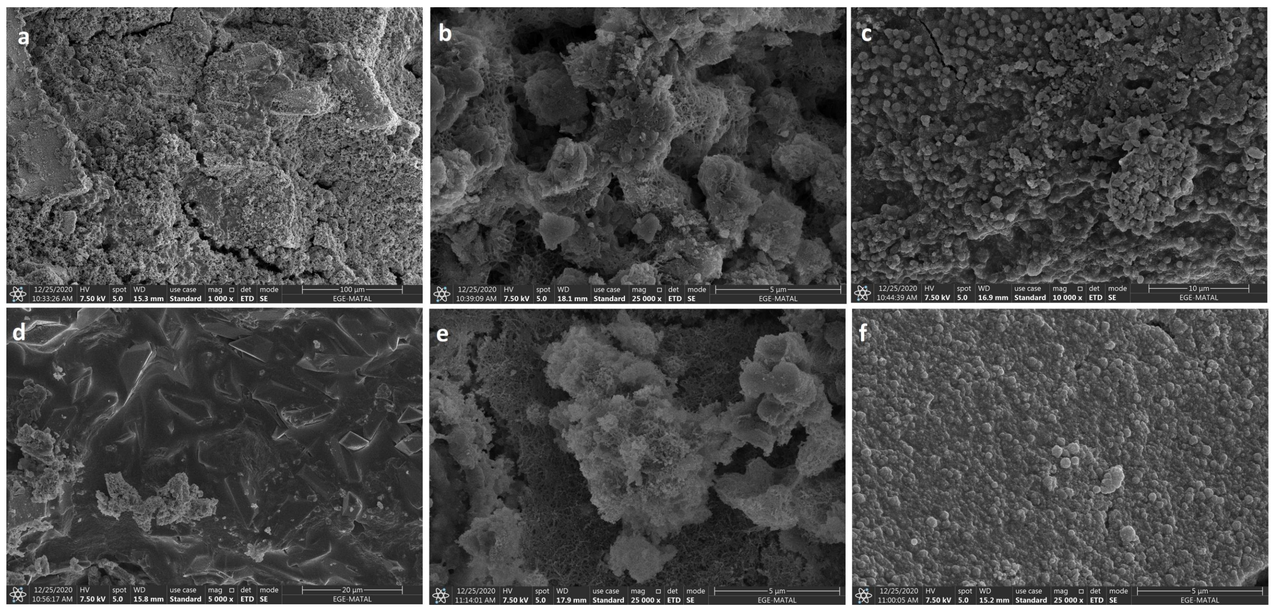

Figure 3. SEM micrographs of chemobrionics; **a**. Ca-Si, **b**. Mg-Si, **c**. Cr-Si, **d**. Ca-CO_3, **e**. Mg-CO_3, **f**. Cr-CO_3.

CONCLUSION

- In this study, different growth regimes and microstructures were observed, which are dependent on the reactivity, concentration and density of the used reactants.
- For the further investigations, chemical and physical processes involved in chemobrionics formation should be well characterized in terms of understanding the complex structure by the development of different methodologies, such as controlling of tube growth, increasing the strength of structures or using a support material that provides a confined area and makes easier the harvesting process.