

Mechanisms of calcite crystallization pressure

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Crystallization pressure, σ_c , is well documented in the geological record[1-3] and the weathering of buildings and monuments[2]. One may easily deduce the thermodynamic limit of this pressure $\sigma_c = (RT/v) \ln(c/c_0)$, where v is the molar volume c the concentration in the solution and c_0 the concentration in equilibrium with the solid. Crystallization pressure can only occur out of equilibrium ($c/c_0 > 1$) where several processes compete to control the rate and thereby the pressure. The study of these processes in the grain contact with a high degree of control of supersaturation, c/c_0 , is necessary to understand the true limits of crystallization pressure. We present a novel experimental approach using microfluidics for containment and control of supersaturation and reflected interference contrast microscopy to study the dynamics of the grain contact under normal pressure during growth of calcite in a microfluidic “vein”.

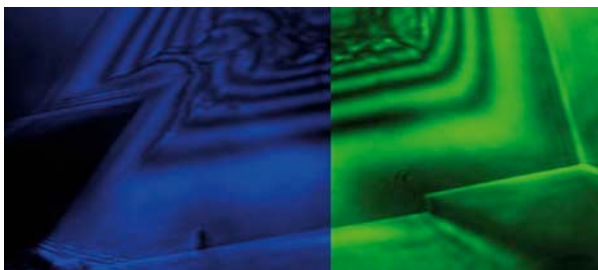


Figure 1 Interference fringes with blue LED ($\lambda=430$ nm) and green LED ($\lambda=560$ nm) as light sources. Using different wavelengths therefore allows us to establish that the contact between this crystal and the glass is along the rim and that the central part about 1.1 micrometer deep.

[1] Gratier, J.P. et al, *How travertine veins grow from top to bottom and lift the rocks above them: The effect of crystallization force*, *Geology* **40**, 1015 (2012).

[2] Bucszynski, C., Chafetz, H. S., *Siciliclastic grain breakage due to carbonate crystal growth*, in *Calcretes*, Wright, V.P., and Tucker, M.E., eds. IAS Reprint Series #2, p. 279 (2009).

[3] Rothrock, E. P., *On the Force of Crystallization of Calcite* *J. Geology* **33**, 80 (1925)

[4] Flatt, et al, *Chemo-mechanics of salt damage in stone*, *Nature Communications* **5**, 4823, (2014).