

MONITORING EARLY-AGE CRACK FORMATION IN A Ca-Fe-Al-RICH INORGANIC POLYMER

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Goal: Understanding the formation of cracks originated by shrinkage in inorganic polymers

Materials:

- Two activation solutions ($\text{SiO}_2/\text{K}_2\text{O}$ ratio of 1,6) with a $\text{H}_2\text{O}/\text{K}_2\text{O}$ ratio of 15.85 (60 wt% water, **60M**) and 42.26 (80 wt% water, **80M**).
- Slag from plasma gasification/vitrification of waste:

SiO_2	CaO	Fe_2O_3	Al_2O_3	Na_2O	MgO	ZnO	TiO_2	CuO	Others
33.6 %	21.7 %	19.9 %	11.9 %	4.0 %	3.4 %	1.9 %	1.7 %	1.1 %	0.9 %

Measuring tools:

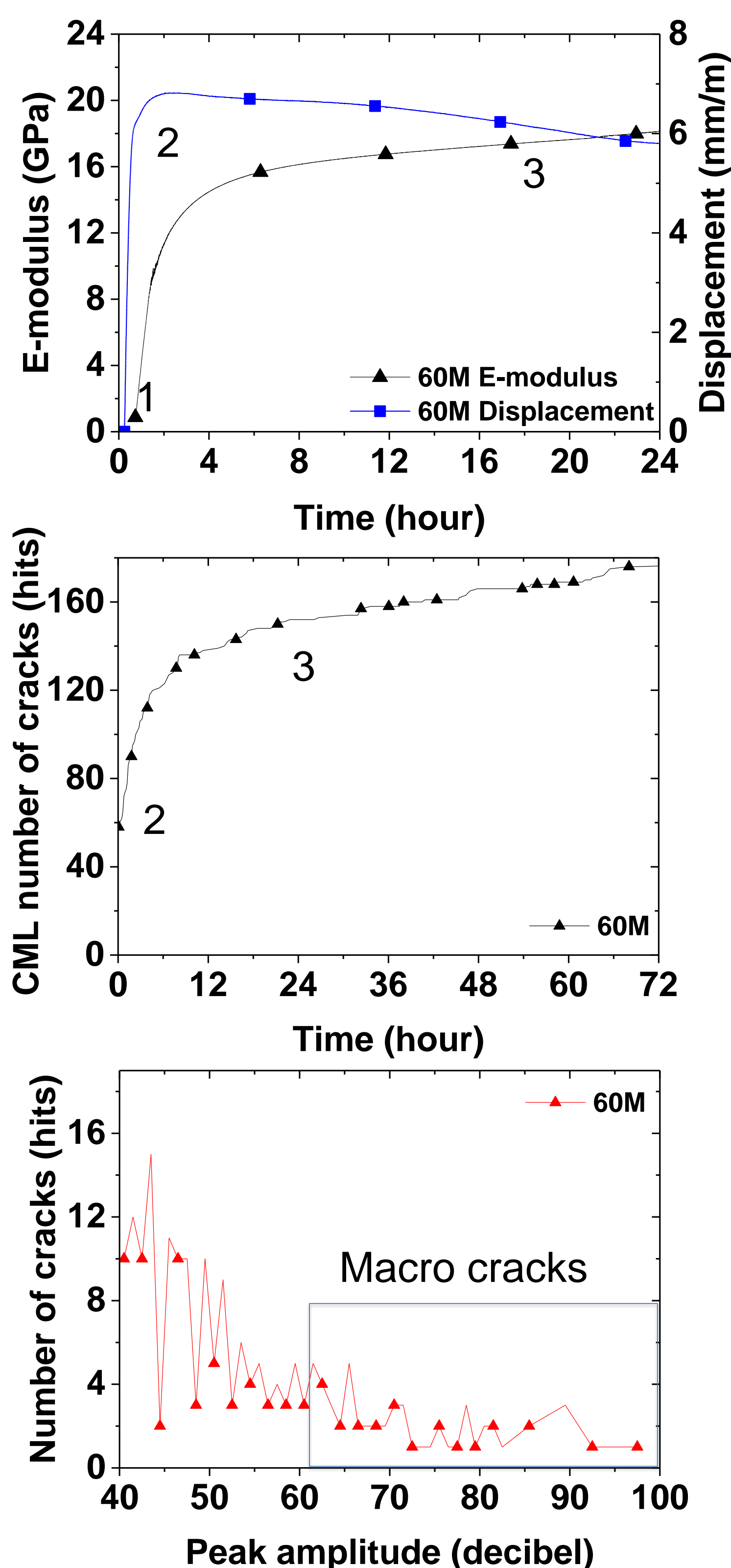
Cracks were recorded by their acoustic wave which travelled through the sample up to a sensor (350 kHz frequency) and registered as hits, each with its own peak amplitude in decibel (dB).

The emission of longitudinal pulses through the sample at a frequency of 500 kHz resulted in a time delay which gave an indication for the E-modulus or stiffness.

The vertical displacement was measured by the voltage difference of a Linear Variable Differential Transformer once a Teflon floater was placed on the mortar surface.

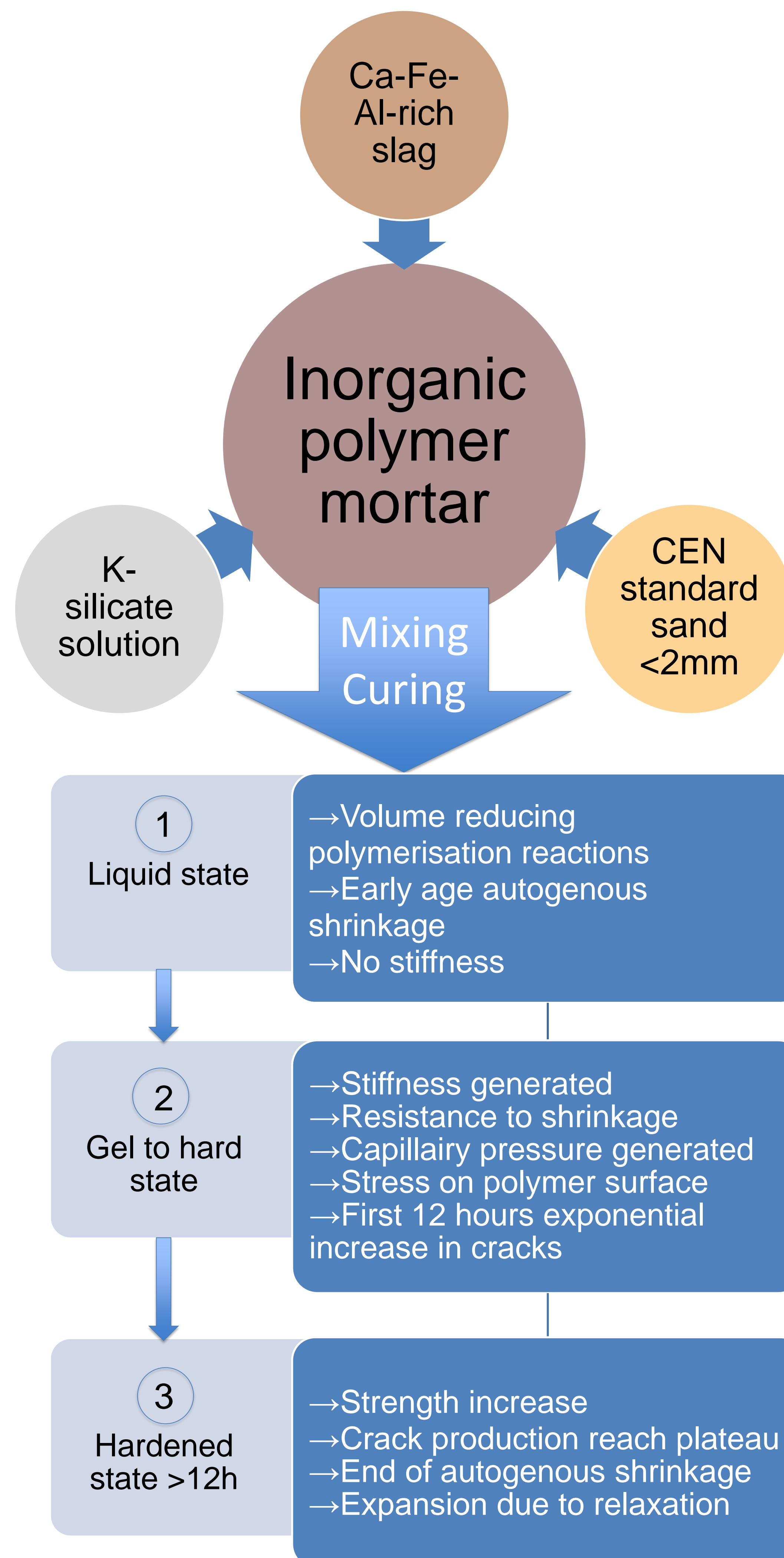
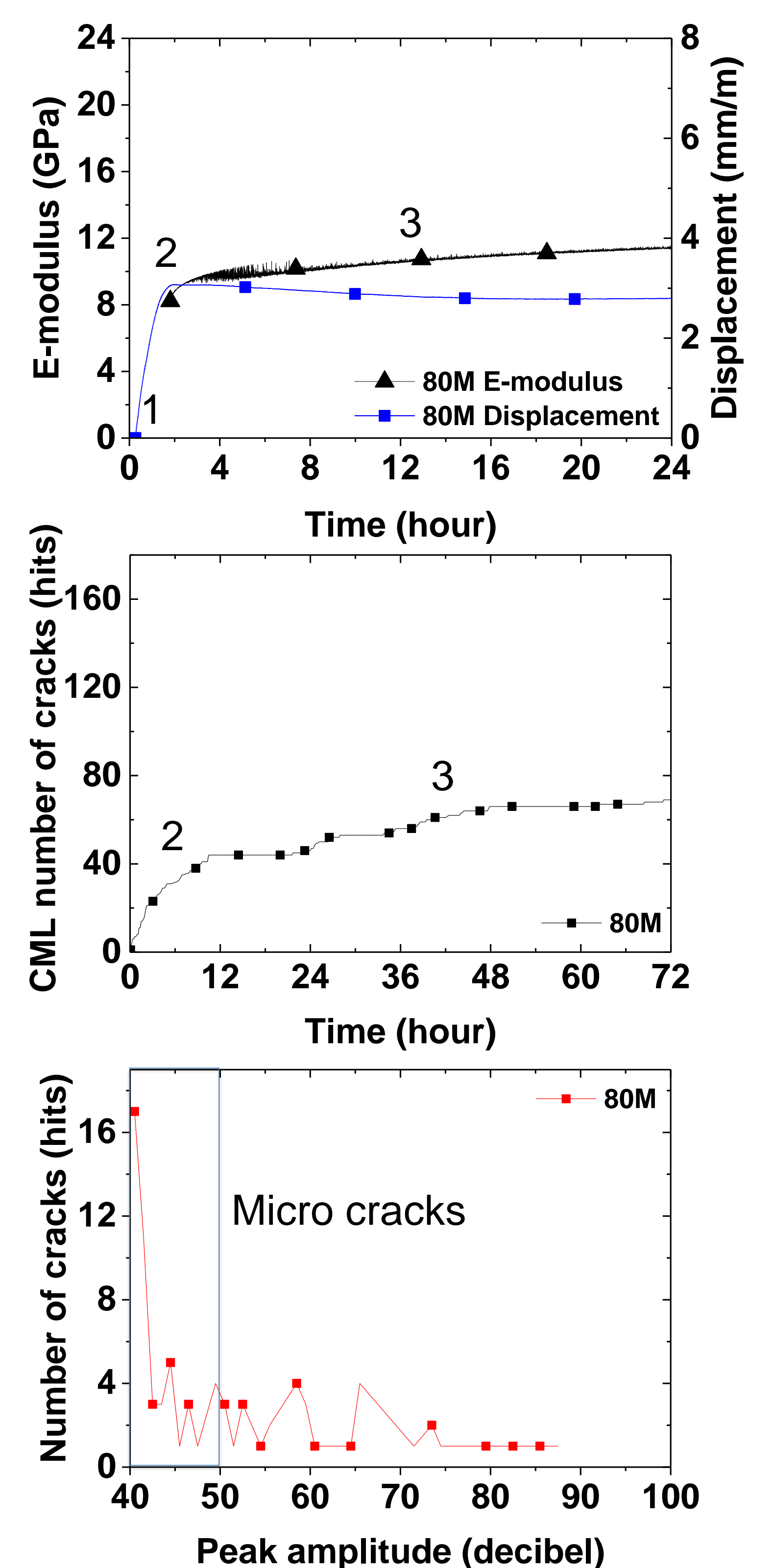
60 wt% water

Lower $\text{H}_2\text{O}/\text{K}_2\text{O}$ ratio resulted in fast stiffness development, causing more stress which exceeded the sample strength and resulted in a high number of cracks.



80 wt% water

Higher $\text{H}_2\text{O}/\text{K}_2\text{O}$ ratio: decrease in rate of network formation leads to retardation of elasticity development. Outcome is less stress and a smaller number of cracks.



Conclusion: Ca-Fe-Al silicate glass was activated with two activating solutions, with varying water content. The choice of the activating solution influenced the shrinkage behavior, the elasticity development and the amount of cracks formed. At a certain elasticity, further shrinkage was inhibited, which induced stress in the inorganic polymer through capillary pressure build up. The production of cracks ceased, after 12h of curing, once sufficient strength was developed.