Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

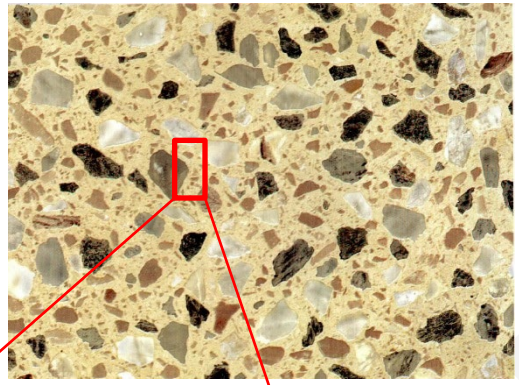
Nanomechanical properties of C-S-H gel/cement grain interface by using nanoindentation and modulus mapping

Jing XU, David J CORR, Surendra P SHAH

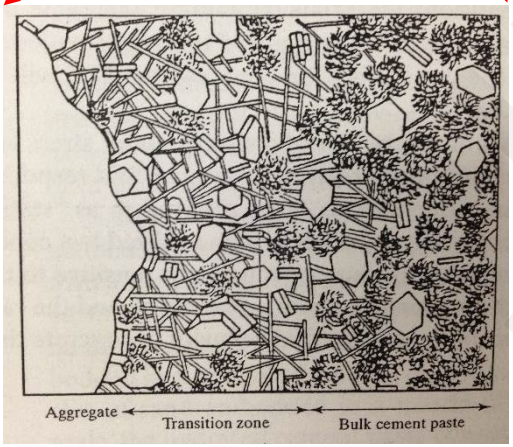
Cite this as: Jing XU, David J. CORR, Surendra P. SHAH, 2015. Nanomechanical properties of C-S-H gel/cement grain interface by using nanoindentation and modulus mapping. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 16(1):38-46. [doi:10.1631/jzus.A1400166]

Interface in Cementitious Materials

At micro-scale



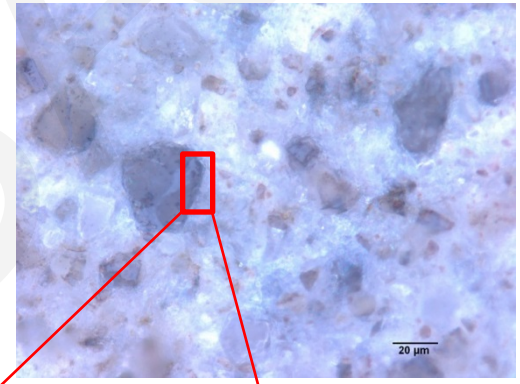
Interface between aggregate and paste



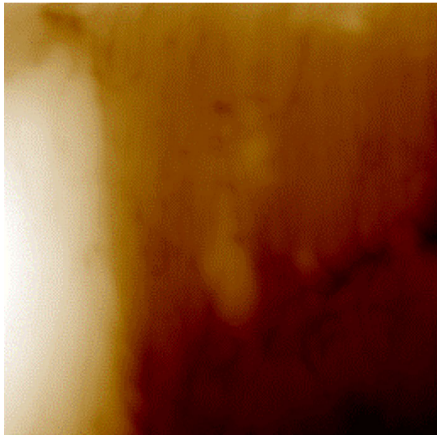
Testing: Microhardness



At nano-scale



Interface between CSH and cement grain

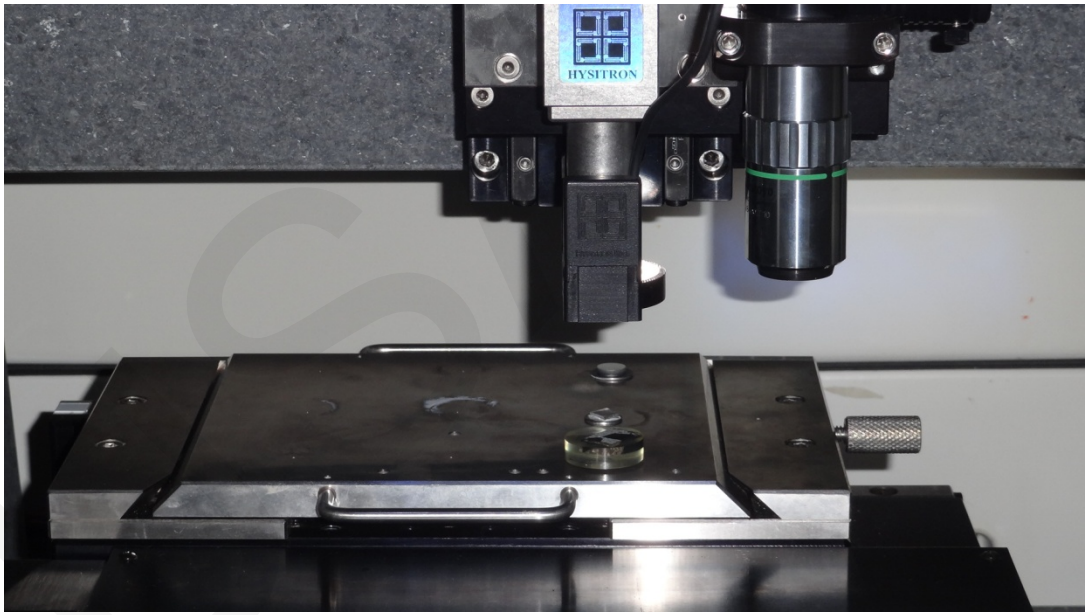


Testing

?

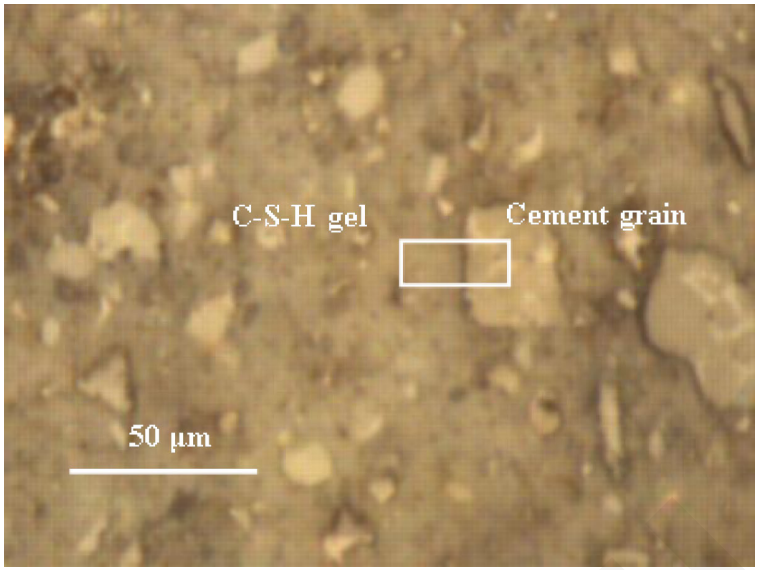
Nanomechanical Investigation



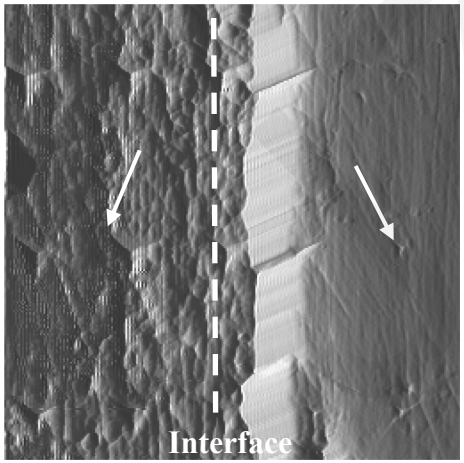


Testing at Nanoscale:
Nanoindentation
Nanosratch
Modulus Mapping
…

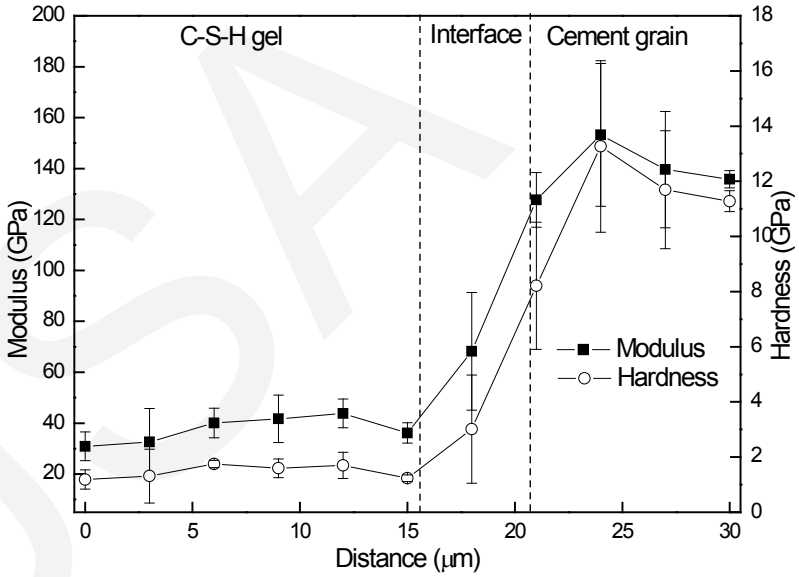
Nanoindentation



Optical image



In situ image of the indents near interface



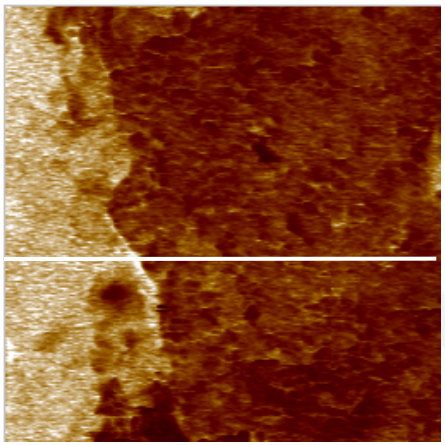
Modulus and hardness vs. position

Interface width: rough estimation <5 um
Interface modulus: 68 Gpa
Interface hardness: 3 GPa

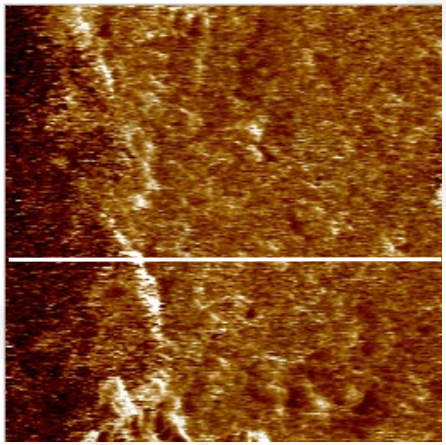
Modulus Mapping

Comparison of nanoindentation and modulus mapping

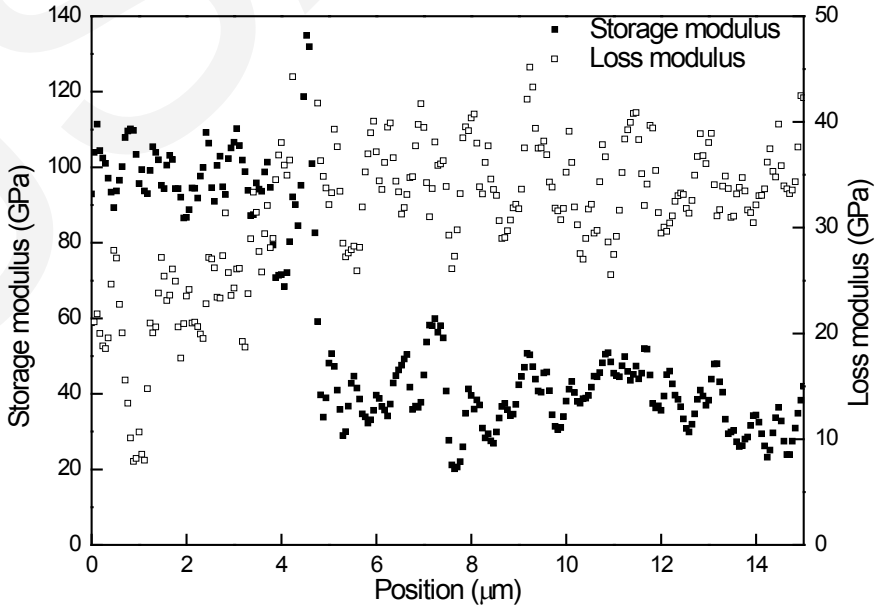
	Contact force (μN)	Step size (nm)
Nanoindetation	1200	3000
Modulus mapping	8	60



Storage modulus map

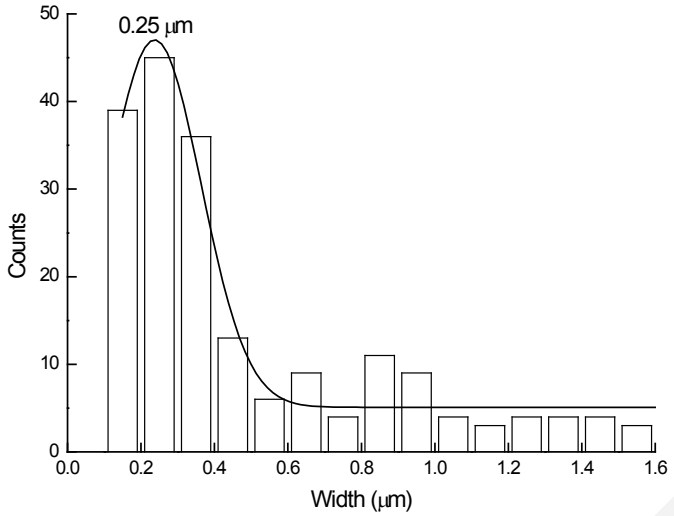


Loss modulus map

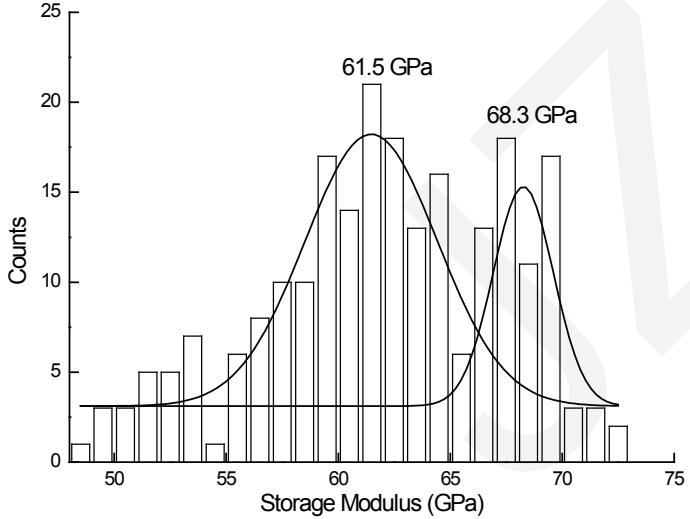


Variations at specific cross section

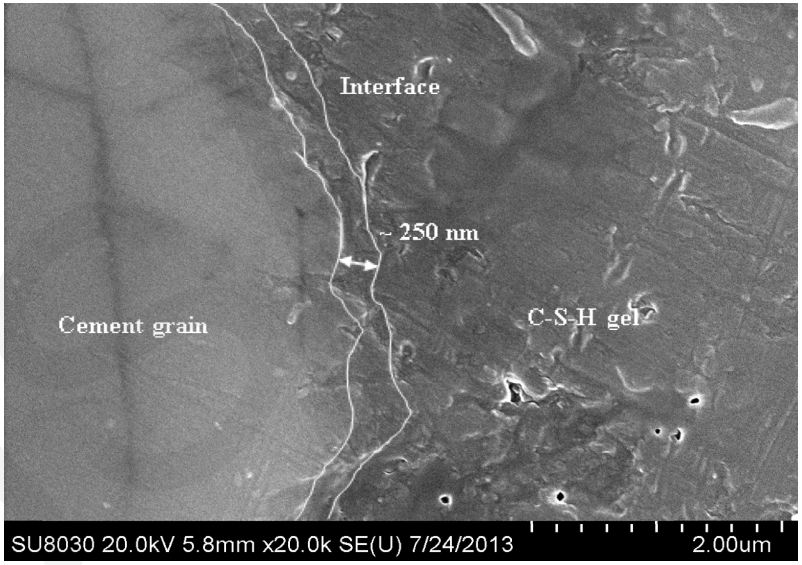
Modulus Mapping



Interface width distribution functions



Interface storage modulus distribution



SEM image of interface

Interface width: 250 nm
Interface modulus: 60-70 Gpa

Conclusions

- Nanoindentation results provided a rough estimate of interface width of less than 5 μm. The modulus and hardness of the interface were 68 GPa and 3 GPa, respectively.
- Modulus mapping yielded an interface width of 250 nm. The packing density in the interface was non-uniform as two peaks of value 61.5 GPa and 68.3 GPa were observed for the storage modulus distribution. This interface could be regarded as a dense layer around cement grains.

JZUSA