All in one: Laboratory-on-a crystal for multifunctional, multiscale probing of thin films

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We developed a novel experimental platform to correlate optical, electrical, gravimetric, and viscoelastic properties of thin films under controlled environment. This new platform enables high-throughput multifunctional materials characterization on a continuous scale, from meso scale down to nanoscale on the same sample. The system uses specially modified AT cut quartz crystal microbalance, QCM, to enable electrical (impedance, resistance), optical, gravimetric, viscoelastic measurements simultaneously under controlled environment (light, gas, vapor atmosphere). Specially designed 3D printable cell can be printed using materials suitable for aggressive environment while conducting multimodal testing. We demonstrated seamless operation of platform and characterized same area of thin film composite using confocal fluorescence imaging (sub-micron resolution) and using multimode AFM (nanoscale) thus creating a continuous (macro-to nano) scale map of the composite dynamic functionalities. Changes in the frequency dependent QCM for different environmental conditions and scanning probe microscopy (SPM) were used to tease out the correlation between macroscale changes in shear modulus and viscosity and local elastic modulus of composite film. We will show how machine learning tools can be used to correlate different functional properties of a thin film during exposure to environment during exposure to environment. The Laboratory-on-a-crystal is now part of CNMS user capabilities.

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REFERENCES

E. Muckley, L. Collins, B. R. Srijanto, and I. N. Ivanov, Machine Learning-Enabled Correlation and Modeling of Multimodal Response of Thin Film to Environment on Macro and Nanoscale Using "Lab-on-a-Crystal" Adv. Funct. Mater. (2020) DOI: 10.1002/adfm.201908010

FIGURES