Interfacial interaction: the fifth element of Sinners Circle

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Temperature, time, chemistry, and mechanical action are the four factors that dermine surface cleaning effeciency and economic return, as defined by the Sinner's circle. It is a principle applied in a broad spectrum of cleaning applications across multiple length scales.

From a tribological persepective, cleaning upon mechanical action is a wear process that is controlled by the interfacial interaction. A customised mechanical tester, coupled with a visulisation system, was used to quantitatively measure the frictional force experienced by a porous cleaning device, which enables us to establish real time correlation between friction and cleaning kinetics as a function of solvent quality. Atomic Force Microscopy (AFM) and X-Ray Tomography were deployed the structural characteristics and surface interaction of the cleaning devices, respectively.

Our results show that the Coefficient of Friction is closely correlated with the cleaning process, subject to whether and how quickly the solvent involved could migrate into the surface foulant. Most importantly, we found that the interfacial interaction, measured by AFM based Force Spectroscopy, plays a vital role in surface cleaning: a non-polar solvent can significantly delay (or completely inhibit) the surface cleaning. This finding was not only evidenced by the nanoscopic surface adhesion data of a set of solvent-surface combinations, but the corresponding macroscopic cleaning actions captured by the camera. To further demonstrate our finding, solvents of varied viscosity were introduced as the cleaning medium, which showed consistent result to the non-polar solvent. The findings suggest that interfacial interaction could be an effective lever in delivering sustainable cleaning where less water, less chemical are used to conclude an increased degree of cleaning.