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Mechanophore activation in a crosslinked polymer matrix via instrumented indentation CHELSEA DAVIS, Purdue University, JEREMIAH WOODCOCK, RYAN BEAMS, MUZHOU WANG, STEPHAN STRANICK, AARON FORSTER, JEFFREY GILMAN, NIST — Recent advances in mechanically-activated fluorophores will enable a host of unique scientific challenges and opportunities to be addressed. Several mechanophores (MPs) in polymers have been reported, yet the specific deformation required to activate these molecules in a bulk polymer network has not been sufficiently specified. In an effort to develop the mechano-activation/deformation relationship of a spirolactam-based MP, scratches were applied to a MP-functionalized glassy crosslinked material at varying normal loads and lateral displacement rates. This experimental design allowed strain and strain rate effects to be decoupled. The fluorescence activation was then observed. Areas of elastic and plastic deformation as well as brittle fracture were observed within each scratch as the normal loading of the indenter increased. The fluorescence intensity increased while the fluorescence lifetime decreased with increasing strain. Hyperspectral imaging revealed that the peak emission wavelength remained constant in the damage zone relative to the undeformed material. Contact mechanics models are employed to demonstrate that relatively high degrees of strain are required to initiate the ring-opening activation transition within the spirolactam-based MP. These self-reporting damage sensors can be incorporated within polymeric coatings to allow real time structural health monitoring for a myriad of applications.

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