Research on the fatigue behavior of Magnesium (Mg) alloys has been significantly increased in view of the renewed interest on their applications. The limited crystallographic deformation mechanisms in hexagonal close-packed (hcp) Mg alloys, including $a$-direction basal, prismatic and pyramidal slip, as well as $c$-direction pyramidal slip and deformation twinning/detwinning results to a distinct mechanical behavior upon cyclic loading, characterized by asymmetric tension/compression yielding, anisotropic hardening and hysteretic loops. In this context, understanding evolving fatigue microstructure-properties-behavior relations in hcp alloys is very challenging in view of the time and length scales involved at both coupon and component levels. To reliably formulate quantitative descriptions of remaining useful life in an Integrated Computational Materials Engineering (ICME) framework in situ/ex situ experimental observations and high-performance simulations continuously provide valuable insights. This talk focuses on describing the role quantitative nondestructive evaluation (NDE) can play in this multidisciplinary effort to identify fundamental mechanisms that dominate fatigue life by presenting results obtained from multiscale mechanical testing combined with NDE and microstructure quantification. Emphasis is given on identifying intervals in time and regions at several length scales in which fatigue damage precursors could be found. Results from targeted observations of the evolution of such precursors are then used to formulate hypotheses on the fatigue behavior of Mg alloys which are implemented in analytical and computational models. Challenges and future opportunities created by adopting this type of approach are also discussed.