This thesis studies multi-phase materials. One such material, dual-phase steel, is nowadays widely applied in car bodies, as it is strong and ductile (as opposed to conventional steels which are strong or ductile). By using such advanced materials, cars can be designed to be lightweight, and thus fuel-efficient, but nevertheless safe in crash situations. Zooming in on the material, the microstructure comprises grains of two phases ("materials"): one hard but relatively brittle and one soft and ductile.

Understanding the resulting mechanical properties of such microstructures, in particular in the damage and fracture regime, entails significant scientific challenges. In fact, many paradoxical observations have been reported in the literature. The objective of this thesis was to unravel the relationship between fracture and the distribution of the phases. A statistical approach was developed, whereby the typical phase distribution around fracture is characterized by averaging a large number of microstructural simulations or experimental observations. This "big data" approach has enhanced the understanding of the fracture mechanisms in multi-phase materials. The developed approach is relevant beyond the micromechanics of fracture, and may assist systematic and objective analyses of other micromechanical phenomena as the relevant phenomena naturally emerge from a manifold of observations.