Collisions of low-energy electrons with molecules lead to excitation of vibrational degrees of freedom or even to bond dissociation. Such phenomena are not fully understood in the case of polyatomic targets since the theoretical treatment is complicated by the multidimensionality of the vibrational dynamics and the interaction of multiple short-lived electronic states. In this thesis, we extend the nonlocal theory of these processes by considering the vibronic coupling through the electron continuum. In particular, we study vibrational excitation of carbon dioxide and dissociation of the N-H bond of pyrrole. For carbon dioxide, the dynamics includes all vibrational modes and three electronic states. The model explains the long-time puzzling shape of the observed energy-loss spectra as well as the origin of a fine structure revealed in a recent experiment. In the case of pyrrole, we study the effect of the motion of distant parts of the molecule on the dissociation.