The reaction between La atom and isoprene (CH$_2$ = CHC(CH$_3$) = CH$_2$) was investigated in a supersonic molecular source. La(C$_2$H$_2$), La(C$_3$H$_4$), and La(C$_5$H$_8$) were observed by time-of-flight mass spectrometry, and their structures and electronic states were characterized by mass-analyzed threshold ionization spectroscopy. Both La(C$_2$H$_2$) and La(C$_3$H$_4$) are three-membered metallacycles formed by the C-C bond cleavage and hydrogen migration. La(C$_2$H$_2$) has a C$_{2v}$ structure, whereas La(C$_3$H$_4$) has a C$_s$ structure. La(C$_5$H$_8$) was identified as lanthano-methyclobutene (La(CH$_2$C(CH$_3$) = CHCH$_2$)) (C$_1$) formed by association and double-bond migration. All three complexes have a doublet ground state with the highest occupied molecular orbital being largely a La 6s character. Ionization removes the metal based electron, and the resultant ion has a similar structure to the neutral complex.