Let $G$ be the complex connected simply connected simple Lie group of type $G_2$ or $F_4$. Let $K$ denote the fixed point subgroup relative to an involution of $G$ that is lifted from a Cartan involution. This talk gives a description of certain components of Springer fibers associated to closed $K$-orbits contained in the flag variety of $G$. These components allow us to describe certain multiplicity polynomials associated to discrete series representations of the real form $G_2^2$ of $G_2$ and the two real forms $F_4^4$ and $F_4^{-20}$ of $F_4$. These goals are motivated by the descriptions of Springer fiber components and the associated multiplicity polynomials for several classical types described by Barchini, Zierau and Graham. A discussion of the progress with regards to $E_6$ will be provided if time permits. (Received January 27, 2014)