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Abstract: This paper reports on studies of the fretting behavior of self-piercing riveted (SPR) joints in titanium sheet materials. Experiments were performed on SPR titanium joints to help understand the influences of sheet thickness and fatigue load level on the fatigue strength and failure mode of the joints. Failed joints were examined using a Scanning Electron Microscope and an Energy Dispersive X-ray machine to study the fretting failure mechanisms of the joints. The results showed that increasing sheet thickness could improve the fatigue strength of the joints at high load levels but less so at low load level. Three failure modes were observed, the pierced sheet failure mode, the locked sheet failure mode and the rivet failure mode. The pierced sheet failure was mainly caused by the fretting wear at the interface between the rivet head and the pierced sheet. The locked sheet failure and rivet failure were generated by the fretting wear at the interface between the rivet shank and the locked sheet. Oxidized wear debris was observed on the surfaces of all the fracture regions of the joints. The main elements of the oxidized wear debris on rivet surfaces were Ti, Zn and O.