Introduction
Examination of alloy components and exposed test coupons from a wide range of biomass-derived oil process environments has indicated susceptibility to internal corrosive attack of widely used 304L/316L stainless steels. The present work seeks to better understand the mechanism of attack by use of advanced scanning electron microscopy (SEM), electron probe microanalysis (EPMA), and scanning transmission electron microscopy (STEM) characterization with focused ion beam (FIB) lift-out techniques. The overall project goal is to acquire enough information that materials with sufficient corrosion resistance can be identified so that materials issues will not prevent the successful commercialization of biomass liquefaction related technologies.

316L (Fe-17Cr-10Ni-2Mo) Pyrolysis Reactor, 500 h at 450-650°C, Mostly Operated at 500°C with Red Oak Feedstock, Iowa State University’s Pyrolysis Process Development Unit

Conclusions
• Internal attack of stainless steels in biomass-derived oil process environments involves both oxygen and sulfur species.
• Alloy grain boundaries are susceptible, with local Ni enrichment and Cr depletion observed across varied exposure conditions.
• Internal sulfidation is frequently associated with the internal attack, with Cr-sulfide formation hypothesized to limit outward movement of Cr to the protective oxide scale.
• Limited short-term exposures suggest 201 stainless steel may better resist internal attack compared with commonly used 304L and 316L stainless steels. The resistance of 201 may result in part from preferential Mn gettering of S.

Reference