Height control feedback is essential for scanning microwave impedance microscopy (MIM) because it regulates the tip-sample interaction, prevents tip crashes, and provides topographic information on the sample surface. We designed and fabricated piezoresistive cantilever probes to enable simultaneous topographic and electrical imaging. The piezoresistive sensitivity is 2 nm for a bandwidth of 10 kHz. High quality piezoresistive topography and MIM images are simultaneously obtained with the fabricated probes at ambient and cryogenic temperatures. These new piezoresistive probes remarkably broaden the horizon of MIM for scientific applications by operating with an integrated feedback mechanism in a low temperature system and for photosensitive samples.