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Mesoscopic interface defects and subharmonic gap structure in Josephson tunnel junctions of superconducting phase qubits[1] R.P. ERICKSON, D.P. PAPPAS, National Institute of Standards and Technology — We compare the measured I-V curves of several samples of superconducting phase qubits and fit them to a theoretical model that accounts for mesoscopic point-contact defects, or pinholes, at the Josephson junction interfaces. The pinholes are parametrized by the fraction of interface surface area they comprise. Our model incorporates diffuse inelastic scattering of quasiparticles from the junction interfaces via the Bogoliubov-de Gennes equation, and is an extension of an earlier theory of superconductive tunneling proposed by Shumeiko et al. [For a review, see V.S. Shumeiko, E. N. Bratus, and G Wendin, Low Temp. Phys. **23**, 181 (1997).] We fit our model to subharmonic-gap features observed in phase-qubit samples possessing a mix of single-crystal (c) Re and polycrystalline (p) Al electrodes, as well as single-crystal and amorphous (a) aluminum oxide junctions, including c-Re/c-Al2O3/c-Re and c-Re/a-AlOx/p-Al, with junction thicknesses not exceeding 20 $\mathring{A}$. We report on the I-V fits we obtain and the conclusions that can be drawn about the nature and extent of pinholes within these samples.

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