Is $\gamma$-Al2O3 polar?

Polarity in thin films and polar discontinuities across an interface plays an important role in determining electronic properties. A key example is the conductivity at the LaAlO3/SrTiO3 (LAO/STO) interface, which is proposed to originate from the polarity of LAO. As a consequence, the conductivity does not disappear when LAO/STO is subjected to highly oxidizing conditions. Substituting LAO with another nominally polar material $\gamma$-Al2O3 (GAO) results in an interface conductivity which can be destroyed by annealing in oxygen. We investigate this apparent paradox by revisiting the defect spinel atomic structure of GAO. We show that the polarity is dependent on the distribution of aluminum vacancies which are intrinsically present in GAO to ensure charge neutrality. In particular, certain film thicknesses allow for vacancy distributions that make GAO nominally non-polar along the [001] direction. We further propose that electromigration of aluminum vacancies across atomic layers can alter the polarity, making the GAO film effectively act as a ferroelectric.