Predissociation of the excited $A^2\Sigma^+$ electronic state of the OH radical results from curve crossings with repulsive potentials, namely $4\Sigma^-, 3\Sigma^-, 4\Pi$, producing $\text{O}(^{3}\text{P}) + \text{H}(^2\text{S})$ fragments. Previous experimental and theoretical studies of the $v = 4$ level of the OH $A^2\Sigma^+$ state indicate that predissociation occurs at least 10-fold faster than in lower vibrational levels, resulting in a fluorescence quantum yield that is essentially zero. In the present study, Fluorescence Depletion Infrared (FDIR) spectroscopy, a UV-IR double resonance technique, is employed to characterize the linewidths and corresponding lifetimes of highly predissociative rovibrational levels of the excited $A^2\Sigma^+$ electronic state of the OH radical. A least-squares fit to a Voigt line profile is used to extract the Lorentzian linewidths of the individual dips in the FDIR spectra. The homogeneous linewidth measurements, ranging from 0.23 to 0.31 cm$^{-1}$ FWHM, demonstrate that the $N = 0 \rightarrow 7$ rotational levels of the OH $A^2\Sigma^+ (v = 4)$ state undergo rapid predissociation, with lifetimes $\leq 23$ ps. The experimental linewidths are in near quantitative agreement with first principle theoretical predictions.