Stained glass windows are designed to reveal their powerful artistry under diverse and time-varying lighting conditions; virtual relighting of stained glass, therefore, repre- sents an exceptional tool for the appreciation of this age old art form. However, as opposed to most other artifacts, stained glass windows are extremely difficult if not impossible to analyze using controlled illumination because of their size and position. In this paper, we present novel methods built upon image based priors to perform virtual relighting of stained glass artwork by acquiring the actual light transport properties of a given artifact. In a preprocessing step, we build a material-dependent dictionary for light transport by studying the scattering prop- erties of glass samples in a laboratory setup. We can now use the dictionary to recover a light transport matrix in two ways: under controlled illuminations the dictionary constitutes a sparsifying basis for a compressive sensing acquisition, while in the case of uncontrolled illuminations the dictionary is used to perform sparse regularization. The proposed basis preserves volume impurities and we show that the retrieved light transport matrix is heterogeneous, as in the case of real world objects. We present the rendering results of several stained glass artifacts, including the Rose Window of the Cathedral of Lausanne, digitized using the presented methods.