A cost-effective and environmentally friendly green chemical method, the so-called aqueous chemical growth (ACG) method, was used to deposit chromium/alpha-chromium(III) oxide, Cr/_-Cr2O3, monodispersed particles, for solar absorbers applications. The deposited particles were annealed at various temperatures in a hydrogen atmosphere for 2 h to study the annealing temperature dependence of the structural, chemical and optical properties of the particles grown on tantalum substrates. The deposited Cr/_-Cr2O3 was characterized by X-ray diffraction (XRD), attenuated total reflection (ATR), scanning electron microscopy (SEM), energy dispersive spectrometry (EDS), and diffuse reflectance UV–vis–NIR spectroscopy. The XRD and ATR analysis indicated that by increasing annealing temperature, the particles crystallinity was improved and Ta2O5 was formed around 600 ◦C, due to the fast oxygen diffusion from the deposited _-Cr2O3 toward the tantalum substrate. The optical measurements show that samples annealed at 400 and 500 ◦C exhibit the targeted high absorbing optical characteristics of “Black chrome”, while those annealed below 400 ◦C and above 500 ◦C show a significant low absorptivity and high emissivity.