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# The role of scattering and absorption on the optical properties of birefringent polycrystalline ceramics: Modeling and experiments on ruby ( $\text{Cr:Al}_2\text{O}_3$ )

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 E. H. Penilla<sup>1</sup>, C. L. Hardin<sup>1</sup>, Y. Kodera<sup>1</sup>, S. A. Basun<sup>2</sup>, D. R. Evans<sup>2</sup>, and J. E. Garay<sup>1, a)</sup>

Hide Affiliations

<sup>1</sup>Materials Science and Engineering Program and Department of Mechanical Engineering,  
[University of California](#), Riverside, Riverside, California 92521, USA

<sup>2</sup>[Air Force Research Laboratory](#), Materials and Manufacturing Directorate, WPAFB, Ohio 45433, USA

<sup>a)</sup>Author to whom correspondence should be addressed. Electronic mail: [jegaray@engr.ucr.edu](mailto:jegaray@engr.ucr.edu)



## ABSTRACT

Light scattering due to birefringence has prevented the use of polycrystalline ceramics with anisotropic optical properties in applications such as laser gain media. However, continued development of processing technology has allowed for very low porosity and fine grains, significantly improving transparency and is paving the way for polycrystalline ceramics to be used in demanding optical applications. We present a method for producing highly transparent Cr<sup>3+</sup> doped Al<sub>2</sub>O<sub>3</sub> (ruby) using current activated pressure assisted densification. The one-step doping/densification process produces fine grained ceramics with well integrated (doped) Cr, resulting in good absorption and emission. In order to explain the light transmission properties, we extend the analytical model based on the Rayleigh-Gans-Debye approximation that has been previously used for undoped alumina to include absorption. The model presented captures reflection, scattering, and absorption phenomena in the ceramics. Comparison with measured transmission confirms that the model adequately describes the properties of polycrystalline ruby. In



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be similar to single crystals, confirming the high optical quality of the ceramics.

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