Published Online: 13 January 2016

Accepted: December 2015

The role of scattering and absorption on the optical properties of birefringent polycrystalline ceramics: Modeling and experiments on ruby ($Cr:Al_2O_3$)

Journal of Applied Physics **119**, 023106 (2016); https://doi.org/10.1063/1.4939090

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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^{3+} doped Al_2O_3 (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.

ACKNOWLEDGMENTS

We gratefully acknowledge the funding of this work by a multidisciplinary research initiative (MRI) from the High Energy Lasers–Joint Technology Office (HEL-JTO) administered by the Army Research Office (ARO).