Bulk polycrystalline ceria-doped Al_2O_3 and YAG ceramics for high-power density laser-driven solid-state white lighting: Effects of crystallinity and extreme temperatures - CORRIGENDUM

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The authors of this article [1] would like to correct the following:

- (i) The middle initial of Matthew C. Wingert was omitted.
- (ii) Two in-text citations have been updated for the following sentences due to errors in the reference list:

The behavior of $\text{Ce:Al}_2\text{O}_3$ is consistent with the low-temperature optical behavior of other rare earths doped into oxides, such as Nd- [38, 39] and Er-doped [31] YAG, that exhibit optical 4f to 4f transitions that are shielded from crystal-field interactions by the outer 5d shell.

The bulk ceramic $\text{Ce:Al}_2\text{O}_3$ phosphors were produced using an all-solid-state, one-step reaction-densification route using CAPAD [23, 31].

- (iii) Errors throughout the references necessitate an updated reference list. Below is the proper reference list, which has also been updated in the original article:

1. P. Pust, P.J. Schmidt, and W. Schnick: A revolution in lighting. *Nat. Mater.* **14**, 454 (2015).
2. J.J. Wierer and J.Y. Tsao: Comparison between blue lasers and light-emitting diodes for future solid-state lighting. *Laser Photon. Rev.* **7**, 963 (2013).
3. V. Bachmann, C. Ronda, and A. Meijerink: Temperature quenching of yellow Ce^{3+} luminescence in YAG: Ce. *Chem. Mater.* **126**, 2077 (2009).
4. R.M. Waxler, G.W. Cleek, I.H. Malitson, M.J. Dodge, and T.A. Hahn: Optical and mechanical properties of some neodymium-doped laser glasses. *J. Res. Natl. Bur. Stand., Sect. A* **75**, 163 (1971).

5. P.H. Klein and W.J. Croft: Thermal conductivity, diffusivity, and expansion of Y_2O_3 , $\text{Y}_3\text{Al}_5\text{O}_{12}$, and LaF_3 in the range 77°–300 °K. *J. Appl. Phys.* **38**, 1603 (1967).

6. B. Zhou, W. Luo, S. Liu, S. Gu, M. Lu, Y. Zhang, Y. Fan, W. Jiang, and L. Wang: Enhancing the performance of Ce:YAG phosphor-in-silica-glass by controlling interface reaction. *Acta Mater.* **130**, 289 (2017).

7. K. Waetzig, M. Kunzer, and I. Kinski: Influence of sample thickness and concentration of Ce dopant on the optical properties of YAG:Ce ceramic phosphors for white LEDs. *J. Mater. Res.* **29**, 2138 (2014).

8. C. Cozzan, G. Lheureux, N.O. Dea, E.E. Levin, J. Graser, T.D. Sparks, S. Nakamura, S.P. Denbaars, C. Weisbuch, and R. Seshadri: Stable heat-conducting phosphor composites for high-power laser lighting. *ACS Appl. Mater. Interfaces* **10**, 5673 (2018).

9. K.A. Denault, M. Cantore, S. Nakamura, S.P. DenBaars, and R. Seshadri: Efficient and stable laser-driven white lighting. *AIP Adv.* **3**, 072107 (2013).

10. J. Park, S. Cho, and H. Kwon: Alumnum-ceramic composites for thermal management in energy-conversion systems. *Sci. Rep.* **8**, 17852 (2018).

11. J. Wang, X. Tang, P. Zheng, S. Li, T. Zhou, and R-J. Xie: Thermally self-managing YAG:Ce- Al_2O_3 color converters enabling high-brightness laser-driven solid state lighting in a transmissive configuration. *J. Mater. Chem. C* **7**, 3901–3908 (2019).

12. P. Fulmek, C. Sommer, P. Hartmann, P. Pachler, H. Hoschopf, G. Langer, J. Nicolics, and F.P. Wenzl: On the thermal load of the color-conversion elements in phosphor-based white light-emitting diodes. *Adv. Opt. Mater.* **1**, 753 (2013).

13. Y. Yu, Z. Liu, N. Dai, Y. Sheng, H. Luan, and J. Peng: Ce–Tb–Mn co-doped white light emitting glasses suitable for long-wavelength UV excitation. *Opt. Express* **19**, 19473 (2011).
 14. L. Devys, G. Dantelle, G. Laurita, E. Homeyer, I. Gautier-Luneau, C. Dujardin, R. Seshadri, and T. Gacoin: A strategy to increase phosphor brightness: Application with Ce^{3+} -doped $\text{Gd}_3\text{Sc}_2\text{Al}_3\text{O}_{12}$. *J. Lumin.* **190**, 62 (2017).
 15. M. Raukas, A. Konrad, and K.C. Mishra: Luminescence in nanosize $\text{Y}_2\text{O}_3\text{:Ce}$. *J. Lumin.* **122–123**, 773 (2007).
 16. V. Lupei, A. Lupei, and A. Ikesue: Transparent polycrystalline ceramic laser materials. *Opt. Mater.* **30**, 1781 (2008).
 17. J.Y. Tsao, M.H. Crawford, M.E. Coltrin, A.J. Fischer, D.D. Koleske, G.S. Subramania, G.T. Wang, J.J. Wierer, and R.F. Karlicek: Toward smart and ultra-efficient solid-state lighting. *Adv. Opt. Mater.* **2**, 809 (2014).
 18. A.T. Wieg, E.H. Penilla, C.L. Hardin, Y. Kodaera, and J.E. Garay: Broadband white light emission from Ce:AlN ceramics: High thermal conductivity down-converters for LED and laser-driven solid state lighting. *APL Mater.* **4**, 126105 (2016).
 19. W.T. Silfvast: *Laser Fundamentals*, 2nd ed. (Cambridge University Press, New York, 2004).
 20. T.H. Maiman: Stimulated optical radiation in ruby. *Nature* **187**, 493 (1960).
 21. K.F. Wall and A. Sanchez: Titanium sapphire lasers. *Linc. Lab. J.* **3**, 447 (1990).
 22. M.D. Chambers and D.R. Clarke: Doped oxides for high-temperature luminescence and lifetime thermometry. *Annu. Rev. Mater. Res.* **39**, 325 (2009).
 23. E.H. Penilla, Y. Kodaera, and J.E. Garay: Simultaneous synthesis and densification of transparent, photoluminescent polycrystalline YAG by current activated pressure assisted densification (CAPAD). *Mater. Sci. Eng., B* **177**, 1178 (2012).
 24. E.H. Penilla, Y. Kodaera, and J.E. Garay: Blue–green emission in terbium-doped alumina ($\text{Tb:Al}_2\text{O}_3$) transparent ceramics. *Adv. Funct. Mater.* **23**, 6036 (2013).
 25. E.H. Penilla, L.F. Devia-Cruz, M.A. Duarte, C.L. Hardin, Y. Kodaera, and J.E. Garay: Gain in polycrystalline Nd-doped alumina: Leveraging length scales to create a new class of high-energy, short pulse, tunable laser materials. *Light: Sci. Appl.* **7**, 33 (2018).
 26. P. Sellappan, V. Jayarem, A.H. Chokshi, and C. Davikar: Synthesis of bulk, dense, nanocrystalline yttrium aluminum garnet from amorphous powders. *J. Am. Ceram. Soc.* **90**, 3638 (2007).
 27. N. Thangamari, A.S. Gandhi, V. Jayaram, and A.H. Chokshi: Low-temperature high-pressure consolidation of amorphous Al_2O_3 –15 mol% Y_2O_3 . *J. Am. Ceram. Soc.* **88**, 2696 (2005).
 28. M.H. Nguyen, S.J. Lee, and W. Kriven: Synthesis of oxide powders by way of a polymeric steric entrapment precursor route. *J. Mater. Res.* **14**, 3417 (1999).
 29. D. Ribero and W.M. Kriven: Synthesis of LiFePO_4 powder by the organic–inorganic steric entrapment method. *J. Mater. Res.* **30**, 2133 (2015).
 30. P. Sellappan, C. Tang, J. Shi, and J.E. Garay: An integrated approach to doped thin films with strain-tunable magnetic anisotropy: Powder synthesis, target preparation and pulsed laser deposition of Bi:YIG. *Mater. Res. Lett.* **5**, 41 (2017).
 31. E.H. Penilla, C.L. Hardin, Y. Kodaera, S.A. Basun, D.R. Evans, and J.E. Garay: The role of scattering and absorption on the optical properties of birefringent polycrystalline ceramics: Modeling and experiments on ruby ($\text{Cr:Al}_2\text{O}_3$). *J. Appl. Phys.* **119**, 023106 (2016).
 32. A. Purwanto, W.N. Wang, T. Ogi, I.W. Lenggoro, E. Tanabe, and K. Okuyama: High luminance YAG:Ce nanoparticles fabricated from urea added aqueous precursor by flame process. *J. Alloys Compd.* **463**, 350 (2008).
 33. X. He, X. Liu, R. Li, B. Yang, K. Yu, M. Zeng, and R. Yu: Effects of local structure of Ce^{3+} ions on luminescent properties of $\text{Y}_3\text{Al}_5\text{O}_{12}\text{:Ce}$ nanoparticles. *Sci. Rep.* **6**, 22238 (2016).
 34. T. Tomiki, H. Akamine, M. Gushiken, Y. Kinjoh, M. Miyazato, T. Miyazato, N. Toyokawa, M. Hiraoka, N. Hirata, Y. Ganaha, and T. Fudemma: Ce^{3+} centres in $\text{Y}_2\text{Al}_5\text{O}_{12}$ (YAG) single crystals. *J. Phys. Soc. Jpn.* **60**, 2437 (1991).
 35. D.S. Hamilton, S.K. Gayen, G.J. Pogatschnik, R.D. Ghen, and W.J. Miniscalco: Optical-absorption and photoionization measurements from the excited state of Ce:YAG. *Phys. Rev. B: Condens. Matter Mater. Phys.* **39**, 8807 (1989).
 36. E. Zych, C. Brecher, and J. Glodo: Kinetics of cerium emission in a YAG:Ce single crystal: The role of traps. *J. Condens. Matter Phys.* **12**, 1947 (2000).
 37. G.B. Nair and S.J. Dhoble: Assessment of electron-vibrational interaction (EVI) parameters of YAG: Ce^{3+} , TAG: Ce^{3+} , and LuAG: Ce^{3+} garnet phosphors by spectrum fitting method. *Spectrochim. Acta, Part A* **173**, 822 (2017).
 38. B.F. Aull and H.P. Jenssen: Vibronic interactions in Nd:YAG resulting in nonreciprocity of absorption and stimulated emission cross sections. *IEEE J. Quantum Electron.* **18**, 925 (1982).
 39. N. Ter-Gabrielyan, M. Dubinskii, G. Newburgh, A. Michael, and L.D. Merkle: Temperature dependence of a diode-pumped cryogenic Er:YAG laser. *Opt. Express* **17**, 7159 (2009).
- The authors regret these errors.

Reference

1. E. Penilla, P. Sellappan, M. Duarte, A. Wieg, M. Wingert, and J. Garay: Bulk polycrystalline ceria-doped Al_2O_3 and YAG ceramics for high-power density laser-driven solid-state white lighting: Effects of crystallinity and extreme temperatures. *J. Mater. Res.* (2020). doi: 10.1557/jmr.2019.417.