We Bleed Orange, Green, & Blue: Rapid microwave synthesis of advanced pigments

Omar Rachdi, Casey Young, Sean Muir, and M. A. Subramanian
Department of Chemistry, Oregon State University, Corvallis, OR 97331

Pigments: Old & New

Egyptian Blue | Cobalt Blue | Vermillion | Viridian green




$CaCuSi_4O_{10}$ $CoAl_2O_4$ HgS Cr_2O_3

Pigments have been used from ancient to modern times.

Alchemists once led the search for new and beautiful colors.

Today, scientists lead the search for more durable, abundant, and safe pigments.

Making Advanced Pigments

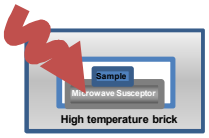
Weigh

Y_2O_3, In_2O_3, Fe_2O_3, CuO, TiO_2, Mn_2O_3

Mix

Agate Mortar and Pestle

Cook



Microwave

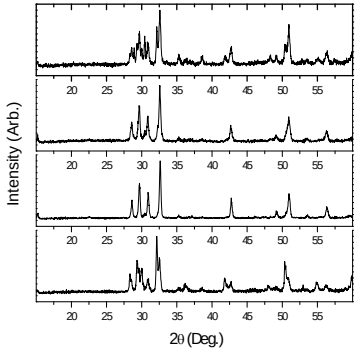
Analyze

X-Ray Diffractometer

UV/VIS Reflectance Spectrophotometer

Progression of a Solid State Reaction

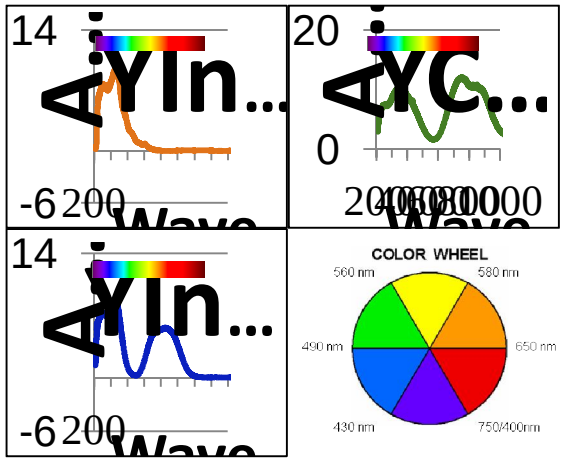
X-Ray Diffraction Patterns for $YCu_{0.5}Ti_{0.5}O_3$



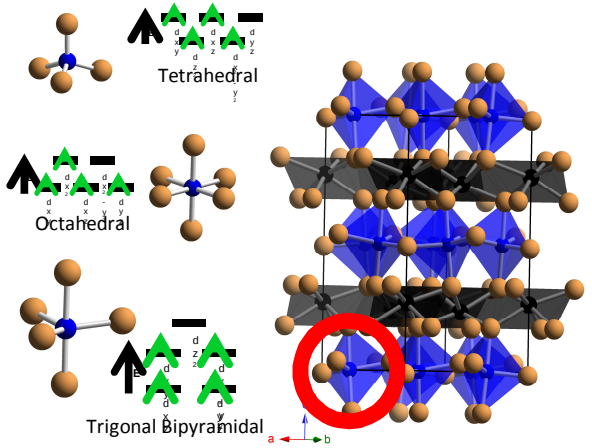
Unit cell parameters and volumes determined using x-ray diffraction as well as heating times

Compound	a(Å)	c(Å)	c/a	Volume (Å³)	Heating Time (min)	Ref
$YCu_{0.5}Ti_{0.5}O_3$	6.172	11.470	1.858	378.40	2880	[1]
$YIn_{0.95}Mn_{0.05}O_3$	6.26	12.2	1.949	414.04	2160	[2]
$YIn_{0.8}Fe_{0.2}O_3$	6.24	12.2	1.955	411.4	1440	[3]

Quantifying Color



Where Does the Color Come From?



The unit cell of these hexagonal YMO_3 based pigments contains a color active trigonal bipyramidal site

Conclusions

Microwave synthesis can be used to rapidly make advanced pigments based on trigonal bipyramidal coordination.

The crystal structure of these materials agrees well with previous reports using traditional furnace based methods.

The color of these materials have been quantified using UV/VIS reflectance spectroscopy.

Acknowledgments & References

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[2] A.E. Smith, H. Mizoguchi, K. Delaney, N.A. Spaldin, A.W. Sleight, M.A. Subramanian, J. Am. Chem. Soc. 131 (2009) 17084.
[3] P. Jiang, J. Li, A.W. Sleight, M.A. Subramanian, Inorg. Chem. 50 (2011) 5858.