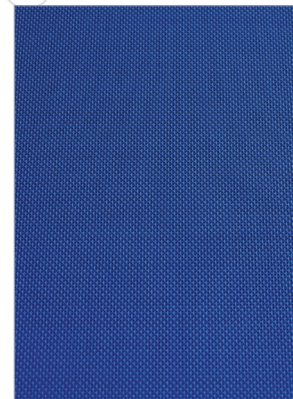


Milliken®

Keyplast™

Colorants for PLA

Polylactic Acid (PLA) has emerged as the volume leader in the world of polymers derived from sources other than petroleum. Derived from ethanol, PLA is broadly used as an alternative to traditional Thermoplastics in beverage bottles, packaging, fibers and textiles. Recently PLA has emerged as a major polymer for 3D printing applications. Touted as a biodegradable alternative (1) the questions have been raised of the biodegradability of colorants used for PLA. Milliken conducted a limited composting study with several colorants. This limited study demonstrated loss of mass during composting for dyes and selected pigments.(2) Additional tests were performed to determine if the colorants migrate from PLA during intended use with favorable results.(3) The following colorants were included in the study. Referenced Materials can be provided by your Milliken representative.



DYES

| | KEYPLAST NAME | COLORANT NAME | DESCRIPTION |
|-----------|---------------------|-------------------|---------------------------------|
| ■ BLUES | Keyplast Blue B | Solvent Blue 35 | Clean, strong medium shade blue |
| | Keyplast Blue KR | Solvent Blue 104 | Red shade blue |
| ■ REDS | Keyplast Red A | Solvent Red 24 | Strong blue shade red |
| | Keyplast Red AA-TL | Solvent Red 111 | Medium shade red |
| | Keyplast Red AG | Solvent Red 135 | Medium shade red |
| | Keyplast FL Red 5B | Vat Red 41 | Blue shade fluorescent red |
| ■ VIOLETS | Keyplast Violet IRS | Solvent Violet 13 | Blue shade violet |
| ■ YELLOWS | Keyplast Yellow 2GH | Solvent yellow 72 | Red shade yellow |
| | Keyplast Yellow 3G | Solvent Yellow 93 | Medium shade yellow |

PIGMENTS

| | KEYPLAST NAME | COLORANT NAME | DESCRIPTION |
|-----------|-----------------------|--------------------|------------------|
| ■ BLACKS | MPC Channel Black | Pigment Black 7 | Channel Black |
| ■ BLUES | Keyplast Blue KG | Pigment Blue 15:3 | Green shade blue |
| ■ REDS | Keyplast Red KPP | Pigment Red 254 | Medium shade red |
| ■ YELLOWS | Keyplast Yellow 3KLTN | Pigment Yellow 110 | Red shade yellow |

ADDITIONAL COLORANTS SUITABLE FOR USE IN PLA BUT NOT INCLUDED IN THE STUDY

| | KEYPLAST NAME | COLORANT NAME | DESCRIPTION |
|------------------------|-----------------------------------|------------------------|-------------------------------------|
| ■ BLACKS | Micropulverized MPC Channel Black | Pigment Black 7 | Channel Black |
| | Keyplast Nigrosine R | Solvent Black 7 | Deep blue shade black |
| | Keyplast Black AMX | Proprietary blend | Blue shade black |
| ■ BLUES | Keyplast Blue BGL | Disperse Blue 60 | Green shade blue |
| | Keyplast Blue A | Solvent Blue 36 | Clean, strong medium shade blue |
| | Keyplast Blue RR | Solvent Blue 97 | Red shade blue |
| | Keyplast Blue KGR | Pigment Blue 15:1 | Red shade blue |
| ■ GREENS | Keyplast Green B | Solvent Green 3 | Blue shade green |
| | Keyplast Green GH | Solvent Green 28 | Yellow shade green |
| | Keyplast Phthalo Green | Pigment Green 7 | Blue shade green |
| ■ ORANGES | Keyplast Orange MR | Disperse Orange 47 | Strong red shade orange |
| | Keyplast Orange LFP | Solvent Orange 60 | Yellow shade orange |
| | Keyplast Orange LFP-HD | Solvent Orange 60 | Yellow shade orange |
| | Keyplast FL Red GL | Proprietary | Fluorescent Orange Red |
| | Keyplast Orange GP | Pigment Orange 64 | Yellow shade orange |
| ■ REDS | Keyplast Red 60 | Disperse Red 60 | Blue shade red |
| | Keyplast Red B | Solvent Red 23 | Strong medium shade red |
| | Keyplast Rubine T | Solvent Red 52 | Strong blue shade/magenta |
| | Keyplast Red AA-TL | Solvent Red 111 | Medium shade red |
| | Keyplast Red AG-HD | Solvent Red 135 | Medium shade red |
| | Keyplast Red A2G | Solvent Red 179 | Medium shade red |
| | Keyplast Red CB | Solvent Red 195 | Strong blue shade red |
| | Keyplast Magenta M6B | Solvent red 207 | Blue shade red/magenta |
| | Keyplast Red H | Proprietary | Blue Shade Red |
| | Keyplast FL Red G | Solvent Red 149 | Blue shade fluorescent red |
| | Keyplast Red Lake C | Pigment Red 53:1 | Strong medium shade red |
| | Keyplast Vat Red V | Pigment Red 177 | Strong blue shade red |
| | ■ VIOLETS | Keyplast Bordeaux HBL | Disperse Violet 26 |
| Keyplast Violet PT | | Solvent Violet 14 | Strong red shade violet |
| Keyplast FL Violet RRN | | Vat Violet 3 | Strong red shade fluorescent violet |
| ■ YELLOWS | Keyplast Yellow G | Disperse Yellow 64 | Medium shade yellow |
| | Keyplast Yellow 6G | Disperse Yellow 201 | Green shade yellow |
| | Keyplast Yellow 4GL | Disperse Yellow 241 | Medium shade yellow |
| | Keyplast Yellow YC | Solvent Yellow 33 | Very green shade yellow |
| | Keyplast Yellow F | Solvent Yellow 104 | Bright green shade yellow |
| | Keyplast Yellow AG | Solvent Yellow 114 | Medium shade yellow |
| | Keyplast Yellow GHS | Solvent Yellow 163 | Red shade yellow |
| | Keyplast FL Yellow Green 7G | Solvent Green 5 | Green shade fluorescent yellow |
| | Keyplast FL Yellow 10GN | Solvent Yellow 160:1 | Green shade fluorescent yellow |
| | Keyplast yellow 3KLTN | Pigment Yellow 110 | Red shade yellow |
| | Keyplast Yellow 7GK | Pigment Yellow 138 | Transparent green shade yellow |
| | Keyplast Yellow RNB | Pigment Yellow 147 | Transparent red shade yellow |
| | Keyplast Yellow KG | Pigment Yellow 180 | Green shade yellow |
| | OPTICAL BRIGHTENER | Keyfluor White OB-1 | Optical Brightener 393 |
| Keyfluor White OB | | Optical Brightener 184 | Blue glow under UV |

1. NatureWorks LLC Website: Products & Applications: Fact or Fiction? <http://www.natureworkslc.com/product-and-applications.aspx> (accessed Aug. 17, 2007).

2. Steele, C.; Treitman, M. Compostable Colorants for Bio-Plastics. In SPE CAD RETEC 2008, Dearborn, MI, September 21-23, 2008 [CD-ROM].

3. Provenzale, G. Lab Report KAC 011GP PLA Resin, Keystone Aniline Corporation, Chicago, IL, November 27, 2006.

PLEASE NOTE: As each customer's use of our product may be different, information we provide, including without limitation, recommendations, test results, samples, care/labeling/processing instructions or marketing advice, is provided in good faith but without warranty and without accepting any responsibility/liability. Each customer must test and be responsible for its own specific use, further processing, labeling, marketing, etc. All sales are exclusively subject to our standard terms of sale posted at www.milliken.com/terms (all additional/different terms are rejected) unless explicitly agreed otherwise in a signed writing.

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