POLYMER INNOVATIONS
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Binder Modifier MW1010 Lamination Aid:

MW1010 is a specialty non-hazardous resin additive which increases the ability to laminate polyvinyl butyral (PVB) based tape casting binders. PVB tapes traditionally do not tack to themselves easily under mild conditions such as those in the tacking operation of multilayer bar building. The use of MW1010 increases the ability to stick layers to themselves very quickly and under mild conditions of heat and pressure making it ideal for bar building in the manufacture of multilayer ceramic components. Testing of MW1010 modified PVB tapes have shown even better tacking performance than acrylic tape casting binders which have traditionally worked better than unmodified PVB tapes.

It is believed MW1010 works by reducing ceramic-PVB interactions which can act as weak crosslinks. These interactions would be expected to slow lamination by restraining polymer chain movement. Another expected benefit of reduced ceramic PVB interaction is reduced slurry viscosity aging especially with boron containing ceramics. Compared to other additives to improve tackiness such as plasticizers, MW1010 has little effect on other tape properties.

A representative formula as used for extremely fast tacking tape is given below. The binder in this formula is a commercially available formulated PVB system. For minimal effect on other tape properties the MW1010 should be used to replace an equivalent amount of organic tape solids. Therefore the ceramic loading of the tape is kept constant. As the MW1010 resin replaces a portion of the binder solids it is a cost effective measure in addition to the performance increase expected. The formula yields a finished tape which is calculated to give about 56% volume loading of ceramic in the green tape. The use of extra toluene was to give a lower viscosity of about 350 cps and is not necessary if a higher viscosity can be tolerated. Other than possible changes in tape tacking, normal slurry milling, casting, and tape processing should be adequate.

Typical barium titanate powder (5.8 g/cc and $3m^2/g$)	59.7 w/w%
B73210 (Ferro PVB binder solution)	32.2
Toluene (as dilution only)	6.0
MW 1010 (lamination modifier from PII)	2.1

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Binder Modifier MW1020 Lamination Aid:

MW1020 is a specialty non-hazardous liquid additive, which increases the ability to laminate polyvinyl butyral (PVB) based tape casting binders. PVB binders normally chemically interact with ceramics through hydroxyl groups on the backbone of the PVB molecule. Although these interactions help produce strong tape excessive interactions can prevent mobility of the PVB molecules during lamination conditions. This can make PVB tapes very difficult to laminate or stack together especially in cases where there are high PVB to ceramic interactions. Frequently these ceramics may be high in boron or other reactive ingredients. These PVB to ceramic interactions even occur in the ceramic slurry and can cause viscosity ageing issues or even slurry gellation. The use of MW1020 or related additive MW1010 resin can help reduce the PVB to ceramic interactions and in doing so can help decrease slurry ageing problems and increase ability to stack and laminate PVB tapes. MW1020 is a liquid and MW1010 is a solid. Depending on the ceramic, either the MW1010 or MW1020 may work better. The PVB to ceramic interactions can be complicated and it is usually best to try both of these materials to see which one is the most effective for the particular ceramic being used.

Since MW1010 or MW1020 can reduce ceramic to PVB interaction it can reduce the overall tape strength somewhat. Therefore it is practical to try several levels to see which one gives the best tape property mix. Depending on the ceramic these MW additives may slow down the PVB to ceramic interaction but may not entirely stop it. Therefore one may see the ageing effects on tape and slurry are slowed down and improved but not entirely stopped.

Representative formulas are shown below. The binder in this formula is a commercially available formulated PVB system. MW1020 is 100% solids and for minimal effect on other tape properties the MW1020 should be used to replace an equivalent amount of organic tape solids. Therefore the ceramic loading of the tape is kept constant. The formulas yield a finished tape, which gives the stated volume loading of ceramic in the green tape. The use of extra solvent was to give a lower viscosity of about 350 cps and is not necessary if a higher viscosity can be tolerated. Other than possible changes in tape tacking, normal slurry milling, casting, and tape processing should be adequate.

	BaTIO3 @55V/V	MgTiO3 @50 V/V
Typical barium titanate powder (5.8 g/cc and 3m^2/g)	59.9 w/w%	
Low Firing MgTiO3 type dielectric (~4.2 g/cc)		44.0
B73210 (Ferro PVB binder solution)	33.2	49.7
70/30 Toluene / ethyl alcohol (as dilutant only)	5.0	5.0
MW 1020 (lamination modifier from PII)	1.9	1.3