Radiation Polymerization

Construction Material Composites

Composites

- Composites are materials in which a new physico-chemical structure matrix is formed, as a result of processing its two or more components

Examples of Composites

Components	Composites
Organic-Organic	Wood-plastic composites; artificial leather; synthetic rubber (ABS, BS, nitrile-butyl-rubber) plastic laminates; automobile tires
Inorganic-Organic	Magnetic tape; safety glass; glass fibre or carbon fibre reinforced plastics; dental plastic cement; clay plastic composite; concrete plastic composite; rubber with inorganic fillers

Construction Materials

- Wood/polymer and concrete/polymer composites
  - •Impregnate porous material with monomers or oligomers
  - •Irradiate to polymerize the monomer/oligomer
- Wood/polymer composites
  - •Dry to appropriate moisture level
  - •Evacuate (1-10 kPa)
  - •Impregnate with monomer or oligomer with appropriate viscosity
  - •Irradiate to required polymerization level (dose ≤30 kGy)

The process enhances hardness, decay resistance and water repellency

Czvikovszky (1992); Woods and Pikaev (1994)

Resins and Additives Used

- Monomers, such as methyl methacrylate, styrene, vinyl acetate, acrylonitrile
- Adhesion and grafting promoters, such as maleic anhydride, alkoxysilanes, and silicone acrylates
- Properties of final product vary with the wood used, and the polymeric materials used

Concrete-Plastic Composites

- Several monomers and mixtures can be used
- Compressive and tensile strengths, and modulus of rupture increase three-fold
- Much better under freezing and thawing
- Water permeability negligible
- Water absorption down to ~ 5%
- Cost ~ twice

Bradley (1984)

Wood-Plastic Composites (Wood, Bamboo)

- *Improved*
  - Moisture resistance
  - Insect damage resistance
  - Weathering characteristics
  - Dimensional stability
  - Hardness
  - Abrasion resistance
  - Tensile strength
  - Bending strength

- Radiation processing typically at ambient temperature (dose < 20 kGy) (thermal processing at elevated temperature)
- Bradley (1984)

Properties of Radiation Processed Wood Plastic Composites

Property	Sangre de Drago			Beechwood		
	None	MMA	ST-AN-UP	None	MMA	ST-AN-UP
Density,kg/m^3	710	1120	1060	723	865	1058
Plastic Content (%)	0	36.0	36.3	0	16.6	32.8
Compression Strength (MPa)	53.2	58.0	67.5	78.5	96.5	85.5
Impact Strength (kJ/m^2)	101.1	44.7	69.8	86.6	65.3	83.7

MMA-Methyl methacrylate
ST-AN-UP- Styrene/acrylonitrile/unsaturated polyester, 54/32/14

Wood Fibre Filled, and Reinforced, Polypropylene

Property	PP	WF/PP	WF/RA/PP	WFRP
Tensile strength (MPa)	37.1	23.9	24.6	28.8
Tensile modulus (GPa)	2.2	4.8	4.4	4.6
Flexural strength (MPa)	61.4	40.1	39.4	51.8
Flexural modulus (GPa)	1.9	2.8	3.1	3.9
Impact strength notched at 20°C (kJ/m^2)	5.5	3.2	2.5	3.0
Melt flow index at 230°C/2.15 kg, g/10 min	5.0	0.4	5.5	6.0

PP-polypropylene; WF - wood fibre; RA - reactive additive;
WFRP - wood fibre-reinforced polypropylene (Czvikovszky, 1992)

Conclusions

- **Some use of radiation processing is being made, e.g., parquet flooring**
- **There is potential for greater use of radiation processing in this field**