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FIRE AND SMOKE RETARDANT MATERIALS DEVELOPMENT

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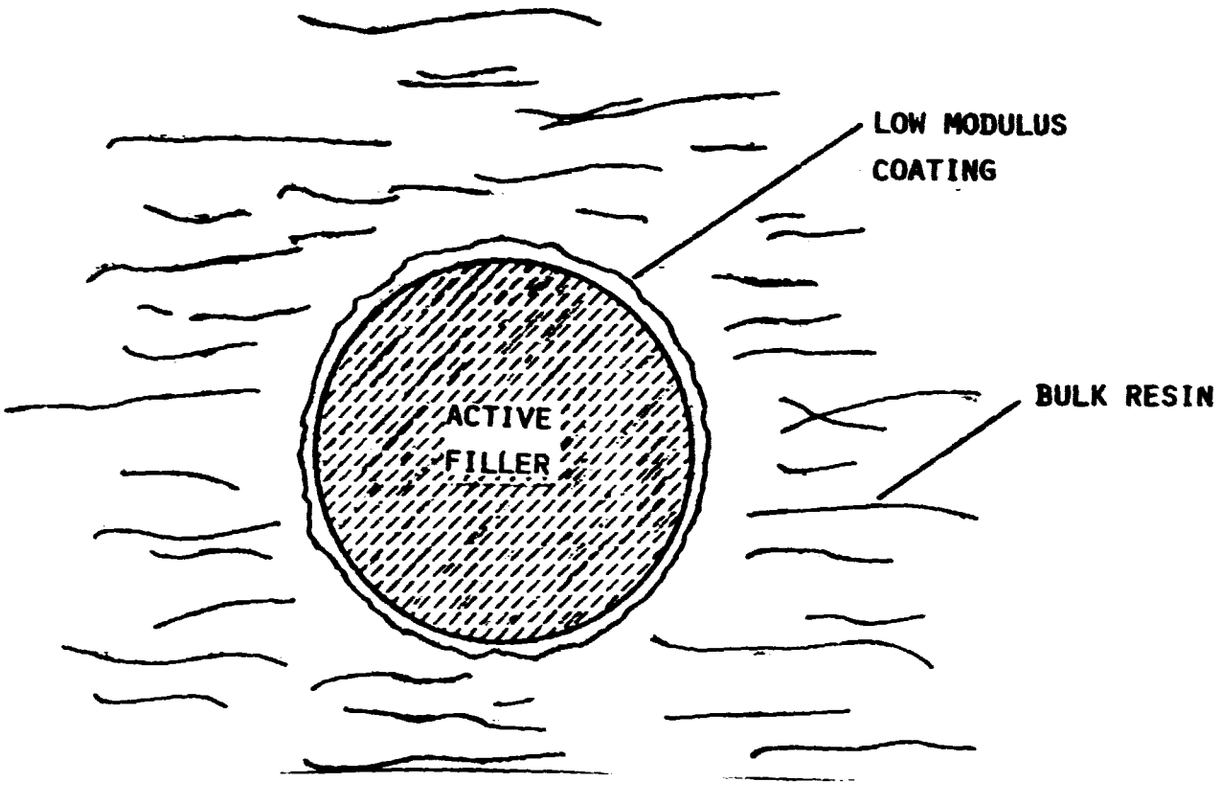
FLAME AND SMOKE RETARDANCE IN PLASTICS MAY BE OBTAINED BY USING INHERENTLY NONFLAMMABLE RESINS, BY THE USE OF ADDITIVES, AND BY USING FILLERS. ACTIVE FILLERS ABSORB HEAT AND RELEASE COOLING GASES SUCH AS WATER VAPOR. THE USE OF FILLERS ALTERS PHYSICAL PROPERTIES, AND, IN PARTICULAR, CAUSES A DECREASE IN IMPACT RESISTANCE, AN ESSENTIAL PROPERTY OF MOLDED PARTS FOR AIRCRAFT INTERIORS. THE PRESENT RESEARCH SEEKS TO PROVIDE A MECHANISM FOR DISSIPATION OF IMPACT ENERGY IN FILLED POLYMERS BY USING FILLERS WITH A LOW MODULUS COATING WHICH WILL DISSIPATE ENERGY THROUGH SHEARING AND CRAZING INSTEAD OF FRACTURE. THE APPROACH OFFERS THE ADVANTAGES OF LOW COST, LOW TOXICITY, AND APPLICABILITY TO VARIOUS RESINS.

SEVERAL METHODS MAY BE USED TO APPLY COATING TO FILLER. FOR MINERAL FILLERS WITH ALKALINE SURFACES, INCORPORATION OF SMALL AMOUNTS OF ACIDIC SITES IN THE COATING AFFORDS READY BONDING BETWEEN THE TWO MATERIALS. A COPOLYMER OF 2-ETHYLHEXYL ACRYLATE (EHA) AND ACRYLIC ACID (AA) HAS BEEN SYNTHESIZED AND EVALUATED. IT IS CROSSLINKED BY THE FILLER PARTICLES, PROVIDING A RUBBERY MATERIAL AND SOME CONTROL OVER MODULUS.

FILLER PARTICLE SCHEMATIC

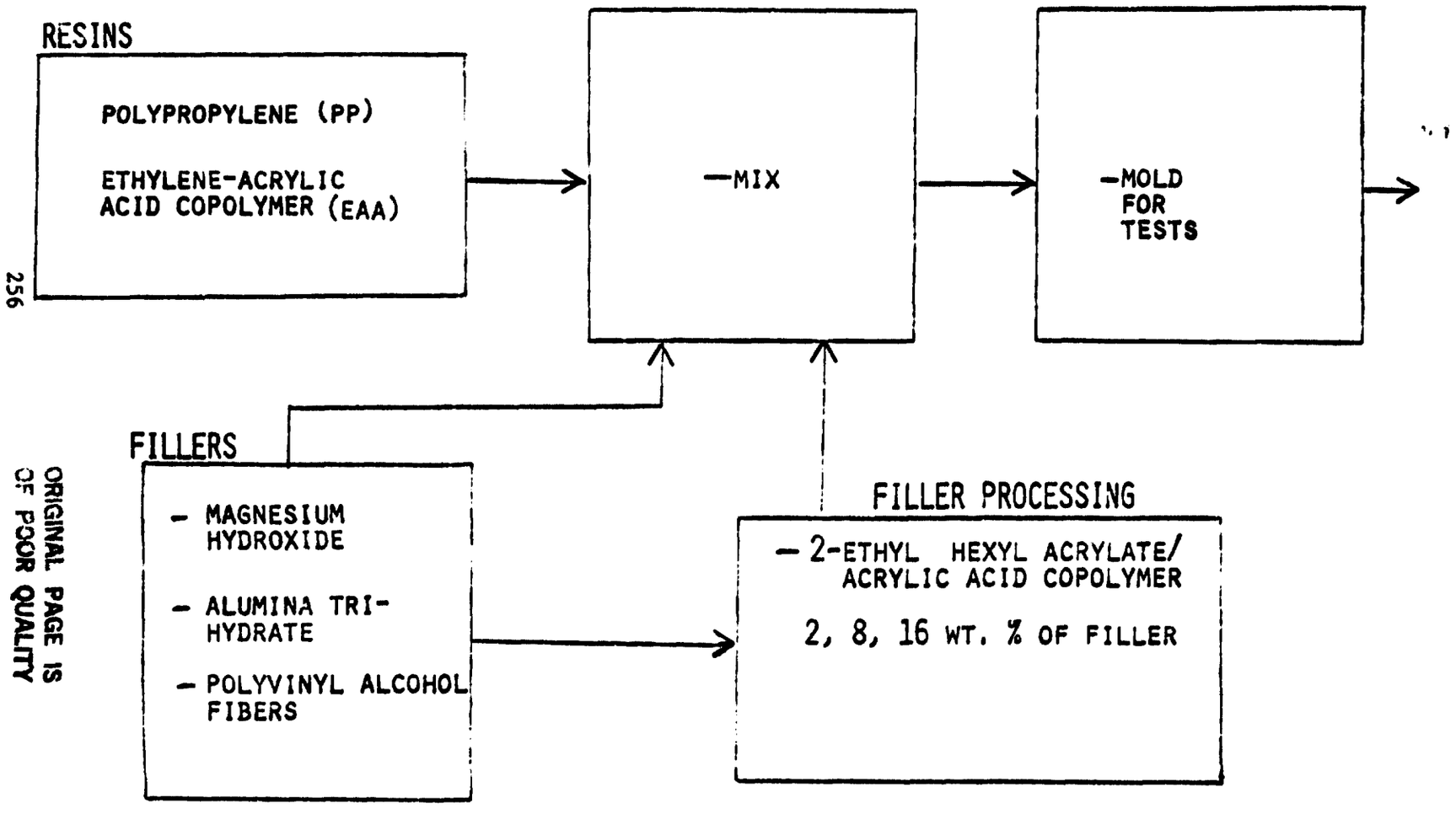


REQUIREMENTS -

- COATING MUST HAVE LOW T_g, $< -40^{\circ}C$
- BONDED TO FILLER AND RESIN
- CONVENIENT PROCESSING

THE RESINS SELECTED FOR INVESTIGATION WERE POLYPROPYLENE (PP) AND ETHYLENE-ACRYLIC ACID COPOLYMER (EAA). MAGNESIUM HYDROXIDE AND ALUMINA TRIHYDRATE ARE EXAMPLES OF ACTIVE MINERAL FILLERS THAT ARE STABLE AT THE REQUIRED PROCESSING TEMPERATURES. POLYVINYL ALCOHOL FIBERS OFFER RELEASE OF WATER ON DECOMPOSITION, LIGHT WEIGHT, AND ARE KNOWN TO IMPART EXCELLENT IMPACT RESISTANCE TO THERMOPLASTIC POLYESTER MOLDING COMPOUNDS. 2-ETHYLHEXYL ACRYLATE-ACRYLIC ACID COPOLYMER BONDS READILY TO MAGNESIUM HYDROXIDE AND ALUMINA TRIHYDRATE, AND IS COMPATIBLE WITH THE RESINS.

EXPERIMENTAL PLAN



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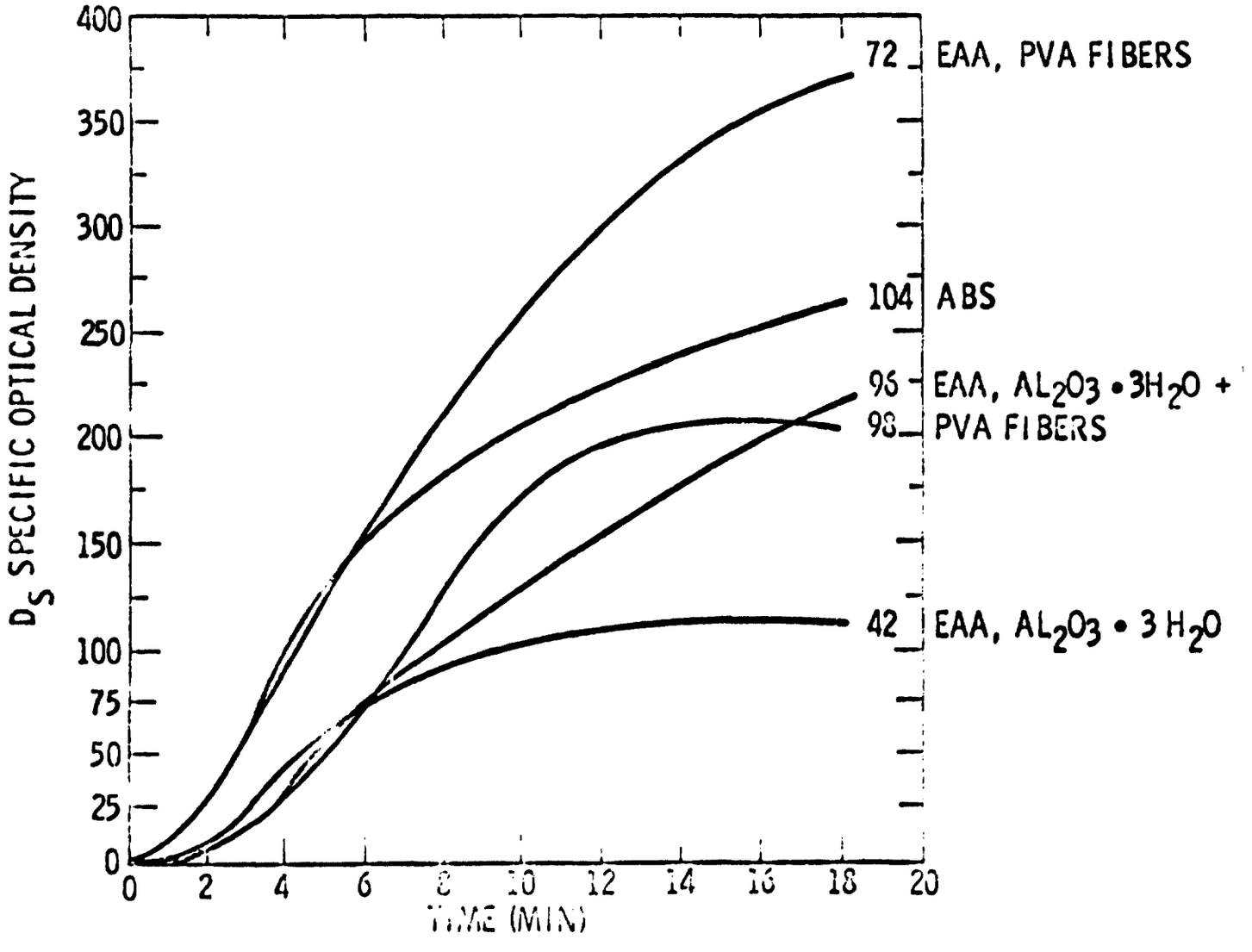
BEST RESULTS UNDER NON-FLAMING CONDITIONS ARE WITH EAA-ALUMINA TRIHYDRATE. PVA FIBERS CAUSE MUCH SMOKE, MORE THAN ~ SMOKY ABS. THESE SAMPLES ALL SHOW SATISFACTORY IMPACT RESISTANCE.

SMOKE GENERATION — NON FLAMING
(NBS SMOKE CHAMBER)



RESULTS UNDER FLAMING CONDITIONS ARE MARKEDLY DIFFERENT FROM NON-FLAMING CONDITIONS. THE EAA/PVA COMBINATION, THE BEST UNDER FLAMING CONDITIONS, IS THE WORST UNDER NON-FLAMING CONDITIONS. THE EAA-ALUMINA TRIHYDRATE COMBINATION, WHICH WAS THE BEST IN NON-FLAMING CONDITIONS, IS ALSO VERY GOOD IN FLAMING CONDITIONS. NOTE THAT MIXTURES OF ALUMINA TRIHYDRATE AND PVA FIBERS ARE SUBSTANTIALLY WORSE THAN EITHER ALONE. THIS MAY BE CAUSED BY A CHANGE IN THE MECHANISM OF DECOMPOSITION.

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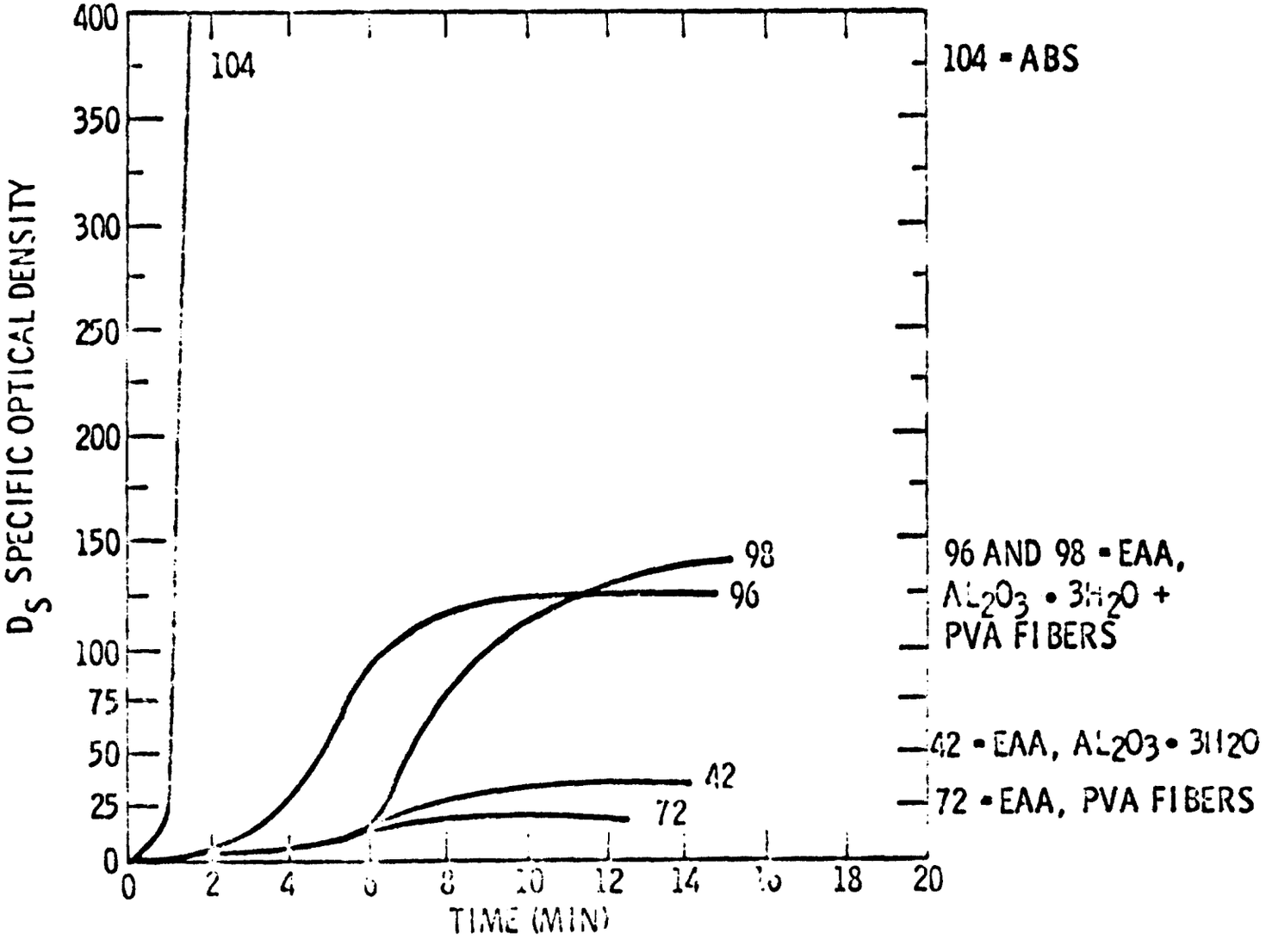
SMOKE GENERATION — FLAMING

(NBS SMOKE CHAMBER)



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THE RESIN-MINERAL FILLER COMBINATION WITH THE BEST IMPACT PROPERTIES WAS EAA-ALUMINA TRIHYDRATE. A FILLER COATING LEVEL OF 8% GAVE THE BEST RESULTS. MAGNESIUM HYDROXIDE-FILLED MATERIALS TENDED TO BE BRITTLE. THE IMPACT RESISTANCE OF POLYPROPYLENE FILLED WITH COATED FILLERS WAS LESS THAN UNFILLED POLYPROPYLENE. POLYVINYL ALCOHOL FIBERS MARKEDLY IMPROVED THE IMPACT RESISTANCE OF BOTH PP AND EAA.

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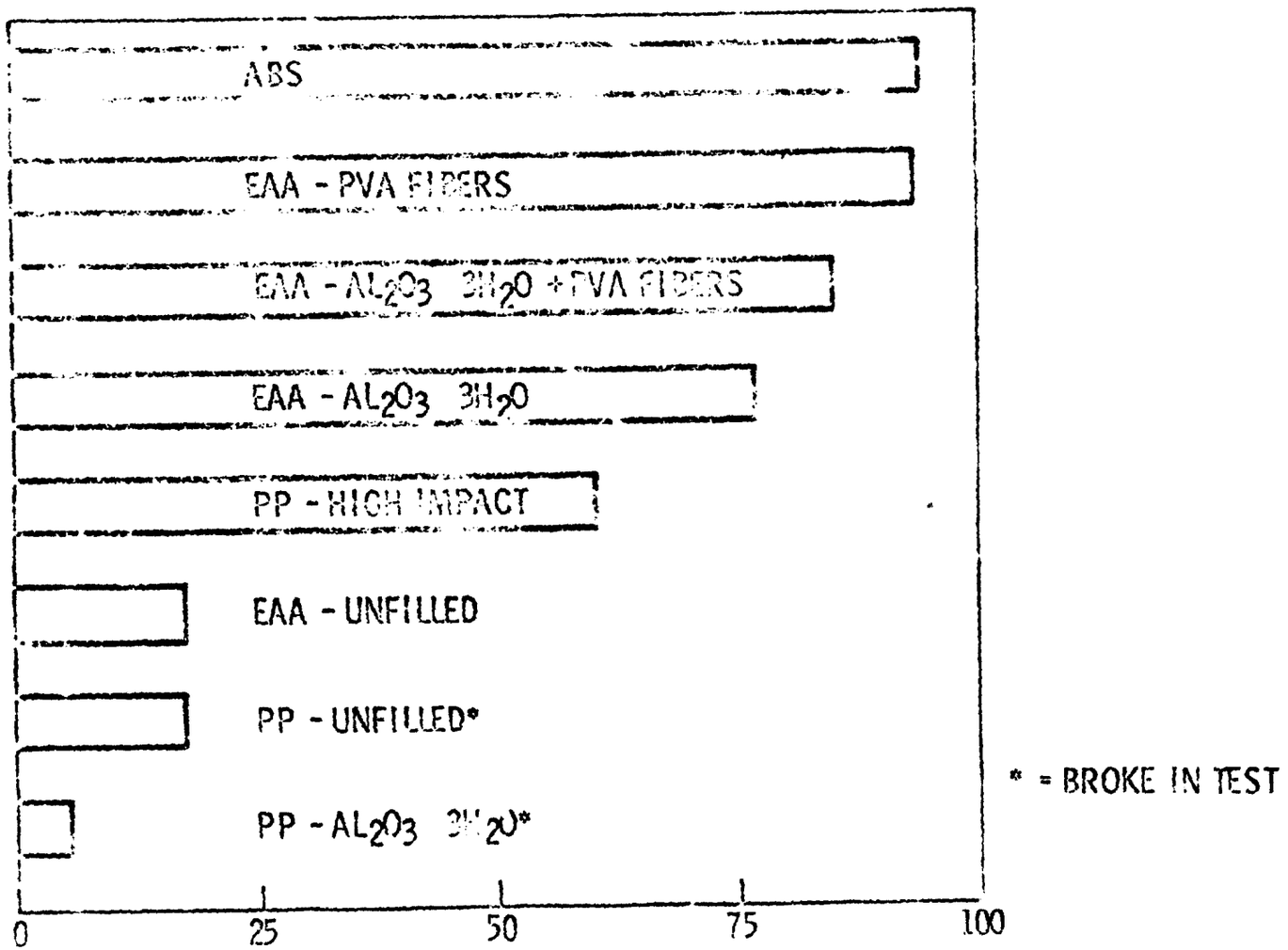
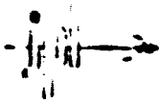
RELATIVE IMPACT RESISTANCE OF VARIOUS MATERIALS



THE USE OF HIGH LEVELS OF ACTIVE FILLERS CAN PRODUCE A MOLDING COMPOUND WITH A SATISFACTORY BALANCE OF PROPERTIES, HOWEVER A WEIGHT PENALTY IS INCURRED. THIS PENALTY IS ESTIMATED AT 200 - 250 LBS FOR AN L1011 OR 747 AIRCRAFT. PVA FIBER GIVES EXCELLENT RESULTS EXCEPT UNDER NON-FLAMING CONDITIONS. THIS MAY BE DUE TO A CHANGE IN THE MECHANISM OF DECOMPOSITION. IF SO, CATALYSIS OF THE REACTION UNDER NON-FLAMING CONDITIONS MAY REDUCE SMOKE EVOLUTION, AND ADVANTAGE COULD THEN BE TAKEN OF THE LIGHT WEIGHT OF THE PVA-EAA COMBINATION.



SUMMARY

EAA-ALUMINA TRIHYDRATE

- LOW SMOKE
- LOW TOXICITY
- LOW COST
- SATISFACTORY IMPACT RESISTANCE
- WEIGHT PENALTY (200 - 250 LBS)

EAA-PVA

- LOW TOXICITY
- HIGH IMPACT RESISTANCE
- WEIGHT BENEFIT (125 - 150 LBS)
- LOW SMOKE UNDER FLAMING CONDITIONS
- HIGH SMOKE UNDER NON-FLAMING CONDITIONS