CHAPER II
LITERATURE SURVEY

2.1 Admicelle Formation and Admicellar Polymerization

The feasibility of admicelle formation and admicellar polymerization has been investigated continually over several years.

O'Rear *et al.* (1988) invented a method for producing polymeric films in which a substrate surface is contacted with surfactant solution. Alumina powder, aluminum plates and sodium dodecyl sulfate were selected as the substrate-surfactant systems for experimentation. The surfactant template, which on solid substrates occurred by adsorption, was obtained as a bilayer of surfactant molecules on the substrate surface. Styrene monomer was dissolved in the surfactant template under suitable conditions resulting in a high concentration of monomer molecules within the surfactant template. Finally, the monomer molecules were polymerized to form a polymeric film dimensionally determined by the surfactant template. The method can be used to coat films on the surface of objects having non-planar surfaces, porous objects, or particulate matter.

Esumi *et al.* (1991) studied the adsolubilization of styrene on alumina using sodium 10-undecenoate as surfactant. They found that polymerization of such a system using UV irradiation occurred in the presence of an initiator. DTA and TGA were used to confirm the presence of poly(sodium 10-undecenoate) and polystyrene. A distinct weight loss and an exothermic peak were observed at about 480^0C for the system in the absence of styrene, which corresponds to a loss of poly(sodium 10-undecenoate), while in a styrene adsolubilized system a main change occurred at about 510^0C, which might be attributed to the decomposition of poly(sodium 10-undecenoate) and polystyrene.

Lai *et al.* (1995) found that polymerization of tetrafluoroethylene within the adsorbed surfactant bilayer took place after thermal initiation with the formation of poly (tetrafluoroethylene) (PTFE) thin films on aluminum oxide powder. In the formation of PTFE, the effects of initiator concentration were studied. The concentration of the initiator showed a marked effect on the amount of

polymerization in the range from 0.25 to 2.5 wt%. The conversion reached 35% for an initiator concentration of 2.5 wt% and 7% conversion for an initiator concentration of 0.25 wt%. Although the conversion was higher for an initiator concentration at or above 2.5 wt%, it should be pointed out that at this concentration there is considerable polymerization in the bulk solution even though the concentration of surfactant is below the CMC – a murky solution was observed in the supernatant. However, this never seemed to happen for an initiator concentration at or below 0.25 wt% (a clear supernatant). Measurements of FTIR, electron probe microanalyzer, friction coefficient and contact angle verified that thin PTFE films were formed on the alumina plates.

Sakhalkar and Hirt (1995) produced organized thin polystyrene films on glass fibers. For the in-situ polymerization of adsorbed monomer, polymer formation was not restricted to the surface aggregates, as originally thought, but a fraction of the polymer formed in the supernatant as well. SEM micrographs of the treated glass fibers showed a nonuniform coating on the fiber surface. Confirmation that the fibers had been coated with polymer was made using UV spectrophotometric analysis following THF extraction of the polystyrene. It was also clear that although polymer formation definitely occurred, the formation of a uniform coating was not achieved.

2.2 Adhesion Improvement in Composites

Numerous researchers have studied composites made from various polymers and glass fibers whose surfaces were treated with silane coupling agents.

Grady *et al.* (1998) succeeded in using a new process for promoting the adhesion of thermosetting resins to a reinforcing fiber. A styrene-isoprene copolymer was polymerized on the surface of glass mat. Epoxy-matrix composites made with untreated cloth, silane-treated cloth, and admicellar treated cloth were evaluated via three point bend tests and single filament pull-out tests. The epoxy-matrix composites made from admicellar treated and silane-treated cloth gave significantly higher strengths in three point bend tests than composites made from untreated cloth. Single filament pull-out tests, which measure fiber-matrix adhesion

directly, and scanning electron micrographs of the failure interface gave results consistent with three point bend tests. Composites made from the admicellar-treated cloth had flexural strengths almost the same as for those made from a commercial silane-treated cloth.

Liang and Li (2000) used the tensile properties of polypropylene (PP) filled with two kinds of A-glass beads of the same size, PP/3000 (glass bead surface pretreated with a silane coupling agent) and PP/3000U (no surface pretreatment), to study the effects of filler surface pretreatment and filler content of these composites. The results showed that the Young's modulus of the composites increased non-linearly with increasing volume fraction of glass beads, while the tensile yield strength and tensile stress at break of the composites decreased with increasing volume fraction of glass beads in the range 0-30%. The value of Young's modulus and tensile stress at break of the PP/3000 system were somewhat higher than those of the PP/3000U system under the same test conditions, but this was in contrast to the tensile strain at break and tensile fracture energy, especially at higher volume fractions of glass beads. In addition, tensile strain at break and tensile fracture energy reached maximum values at a volume fraction of glass beads equal to 25% for both systems. This indicated that there is a brittle-ductile transition for the composites in tension.

Usa *et al.* (2000) succeeded in partitioning ethylene gas into admicelles of sodium dodecyl sulfate on glass fiber. Polymerization of ethylene within an adsorbed surfactant bilayer took place after thermal initiation. Sodium persulfate was used as the initiator. In the formation of polyethylene film, the effect of initiator concentration was studied when using admicelle-treated glass fiber. The results were compared with silane-treated and untreated glass fiber. An increase in the initiator:surfactant ratio led to higher tensile strength. This indicated that the admicelle-treated glass fiber improved the adhesion between the glass fiber and polyethylene matrix, resulting in composites with greater tensile strength.

2.3 HDPE Composites

Michael *et al.* (2001) studied the beneficial effects of coating polyethylene on glass beads by the polymerization-filling technique (PFT). Scanning electron microscopy (SEM) confirmed that the glass beads were homogeneously coated with polyethylene. The coated filler was then mixed with molten HDPE to give a 20 wt% filler content. The ultimate tensile strength and elongation at break of all composites made from unmodified glass beads were expectedly smaller. However, when the glass beads were previously covered by a thin polyethylene layer by the polymerization-filling technique, these properties were improved compared to those of composite containing unmodified glass beads. Remarkably, the impact energy increased by an order of magnitude by precoating the filler. SEM micrographs of the cryofracture surfaces indicated that fracture propagates along the bead/matrix interface in the case of unmodified glass beads. In contrast, fracture occurred uniformly throughout the matrix/glass bead composite filled with coated glass beads due to a slippage of beads which were firmly embedded in the polyethylene matrix when stress was applied.