An Overview of Some Studies in Materials of Interest for the Brazilian Space Program

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INTRODUCCION

In our Graduate Program at Faculdade de Engenharia Quimica da Universidade Estadual de Campinas (UNICAMP), we engaged in different Projects conducted in cooperation researches of the Brazilian Space Program, from Centro Tecnológico da Aeronáutica, as graduate students.

Our satellite launcher has been using solid fuels. Thermal and mechanical stress during storage and flight duration are hard to simulate .We conducted a study, employing the well know time-temperature as a preliminary work to obtain the relaxation modulus in situations of storage and launching. Also investigate, was the synthesis of intermediates for high-energy fuels. Other materials, and technologies of interest were carbon fiber high performance composites, plasma and corona treatments and development of ablative carbon-carbon composites.

PRESENTATION

Mechanical failure of solid fuels can occur during storage, that amounts from months to years, as well as in ignition and flight, which last from milliseconds to minutes , and promote the highest tensions at interfaces between the solid fuel ,and the body of the motor (Duer and Marsh, 1996) , (Gould, R. F., 1976), and (Morais et al, 2000)

The search for a higher energy rubbery matrix that bind the solid fuel components, has led us to study the synthesis of an intermediate, polyepichlorohydrin, where it is critical to obtain high enough molecular weight, as necessary to produce GAP (Glycidyl Azide Polymer) , avoiding during the synthesis the formation of cyclic products (Guanaes et al. 2006).

The synthesis of polyepichlorohydrin , was investigated, (Biedron, et al, 1991) and (Kubisa and Penzcek , 1999) , who proposed the activate monomer route as critical to obtain linear oligomers , with adequate molecular weight, leading to less cyclization , as the result of choosing optimal reaction conditions . The surface modification of carbon fibers with corona and low-pressure plasma discharge, with equipments developed at CTA, was studied by characterizing the chemical nature of the functionalization, measuring surface energy, and its effects on the adhesion (pull out test), and mechanical properties of Carbon Reinforced Composites

A pull out technique, by dynamical mechanical analysis and four points bending of composites evaluated adhesion properties. The effect of the low-pressure plasma, and corona treatment on adhesion was evaluated correlating the surface modification with its effect over mechanical properties of the composites obtained. The treatment proved to be quite effective in increasing mechanical performance of the composites (Rebelo Ferreira, 2000).

Low-pressure plasma was also used to study the modification of EPDM rubber with Oxygen/Argon gas mixture, in order to improve its adhesion in the interface with the solid fuel, an important property for the application in the rocket engine technology (Dutra,2000). The EPDM surface activation process was carried out in a reactive ion etching reactor operated at 13,56 MHz using pure oxygen and a gas mixture of argon and oxygen in different proportions (6:0, 5:1, 2:1, 1:1, 1:2, 1:5, 0:6). In order to investigate the influence of the process parameters on the modifications of the rubber surface, the samples were analyzed for surface energy, morphology, chemical composition, , and adhesion tests performed. The results have shown that this plasma treatment efficiently increased the energy and roughness of the rubber surface, thus enhancing its adhesion characteristics by formation of new oxygen based polar groups, and by increasing the roughness of the EPDM surface.

Low density Carbon-Carbon (CRFC) composites, with good mechanical properties , able to resist temperatures up to 1270 K, were developed as ablative materials, for potential use in reentrance operations (Ferreira,2002).

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