Time-frequency Analysis for Acoustic Emission Signals of Hypervelocity Impact

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The risk of collision of man-made orbital debris with spacecraft in near Earth orbits continues to increase. A major of the space debris between 1mm and 10mm can't be well tracked in Earth orbits. Damage from these un-tracked debris impacts is a serious hazard to aircraft and spacecraft. These on-orbit collisions occur at velocities exceeding 10km/s, and at these velocities, even very small particles can create significant damage. The development of in-situ impact detecting system is indispensable for protecting the spacecraft from tragedy malfunction by the debris. Acoustic Emission (AE) detecting technique has been recognized as an important technology for non-destructive detecting due to the AE signals offering a potentially useful additional means of non-invasively gathering concerning the state of spacecrafts. Also, Acoustic emission health monitoring is able to detect, locate, and assess impact damage when the spacecrafts is impacted by hypervelocity space debris and micrometeoroids .This information can help operators and designers at the ground station take effective measures to maintain the function of spacecraft. In this article, Acoustic emission (AE) is used for characterization and location for hypervelocity Impacts. Two different Acoustic Emission (AE) sensors were used to detect the arrival time and signals of the hits. Hypervelocity Impacts were generated with a two-stage light-gas gun firing small Aluminum ball projectiles (4mm, 6.4mm). In the impact studies, the signals were recorded with Disp AEwin (PAC.) instruments by the conventional crossing threshold method with wideband and resonant sensors. Using the proposed time-frequency method of wavelet transform (WT) to process AE signals, the failure modes at the full penetration and nonpenetration mechanism were made clearer. For the nonpenetration mode, the signals contained extensional and flexural wave components with large amplitude. While for the signals of the full penetration, the extensional wave components dominated the signals with little flexural components. There existed distinct characteristics in the time-frequency of continuous wavelet transform between the signals of the full penetration and nonpenetration, such as frequency range、amplitude of energy and duration. These indicated that wavelet transform processing method of AE signals was a discriminator for the failure modes and powerful for elucidating the mechanisms.