15. SUBJECT TERMS
Spacecraft charging
Space plasma physics
Differential charging

16. SECURITY CLASSIFICATION OF:

<table>
<thead>
<tr>
<th>a. REPORT</th>
<th>b. ABSTRACT</th>
<th>c. THIS PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNCL</td>
<td>UNCL</td>
<td>UNCL</td>
</tr>
</tbody>
</table>

17. LIMITATION OF ABSTRACT
UNL

18. NUMBER OF PAGES
UNL

19a. NAME OF RESPONSIBLE PERSON
Shu T. Lai

19b. TELEPHONE NUMBER (Include area code)
UNL
Reply to comment by M. Bodeau on “Charging of mirror surfaces in space”

Shu T. Lai

Received 27 May 2006; revised 24 August 2006; accepted 30 August 2006; published 16 November 2006.


[1] The first comment of Bodeau [2006] is about the Boeing ownership or acquisitions of companies and satellites. Since I had no knowledge of the companies or the details of acquisitions, and because this is not a scientific question, I will offer no further comment on this point. I thank M. Bodeau for this information.

[2] Bodeau [2006] comments at length, presenting supporting laboratory measurements, that sputtering rates are small and concludes that sputtering can not cause a sudden stepwise loss of power on Satellite PAS-7. Indeed, Lai [2005] has explored sputtering as a plausible mechanism and obtained a numerical estimate of the surface removal rate by sputtering. The rate obtained by Lai [2005] is of the order of $10^{-11}$ cm per month. The conclusion section in the work of Lai [2005] states: “Although the sputtering rate is small, prolonged sputtering would shorten the useful life of the mirrors. Unlike sudden discharges, which may cause damage or stepwise degradation to the solar cells, sputtering causes gradual degradation only to the solar cells.” This conclusion of Lai [2005] is not in disagreement with that of Bodeau [2006].

[3] Bodeau [2006] comments that PAS-7 has no mirror. I thank M. Bodeau for this information. However, the PAS-7 articles posted on 27 and 28 September 2001 on SpaceToday.net (http://www.spacetoday.net/Summary/408) and SpaceDaily (http://www.spacedaily.com/news/panamsat-01b.html), respectively, show a satellite picture with mirrors flanking the solar panels. If PAS-7 does not feature mirrors, I agree that the proposed differential charging mechanism would not apply. For Boeing 702 satellites, see http://www.boeing.com/defense-space/space/bss/factsheets/702/galaxy_xi/galaxy_xi.html. As a consequence of degradation, future 702 satellites will be equipped with conventional solar arrays (see the Sat-Index Web site, available at http://www.sat-index.com/failures/702arrays.html).

[4] The main point in the work of Lai [2005] is a novel postulate that mirrors of high reflectance emit little or no photoemission. With low photoemission, the mirrors may charge to high negative voltages even in sunlight, when the ambient space plasma is hot enough. Charging of mirrors has never been studied in the laboratory. If the satellite surfaces, including parts of the solar panels, emit abundant photoelectrons in sunlight, they would not charge, or charge to low positive potentials only. If so, differential charging may occur on the satellite more often than previously thought. It may occur not only during eclipse periods, which are indeed short, but also sometimes in sunlight when a critical temperature is exceeded. If PAS-7, or any satellite, does not feature reflectors, the proposed differential charging mechanism would not apply.


References


S. T. Lai, Space Vehicles Directorate, Air Force Research Laboratory, 29 Randolph Road, Hanscom Air Force Base, MA 01731-3010, USA. (shu.lai@hanscom.af.mil)

This paper is not subject to U.S. copyright. Published in 2006 by the American Geophysical Union.