
Correlating mechanical damage with electrical resistance of foldable thin films

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Abstract

In order to assess the longevity of foldable electronics, folding or bending tests on model systems need to be performed to determine how the electrical resistance changes with the evolution of mechanical damage. However, not all bending tests are created equal in that different configurations lead to different amounts of mechanical damage, thus different electrical response. Two 90° bending instruments were compared using two model metallic thin film systems on polyimide to establish if the two seemingly similar bending tests yield the same results in mechanical damage and electrical resistance. For statistics, 10-12 samples were tested of each film systems on each folding device using the same applied bending strain and number of cycles. Samples were intermittently characterized with confocal laser scanning microscopy and electrical resistance to correlate the amount of mechanical damage (crack density) and the electrical normalized resistance ratio of the damaged area. Results will show that even with the same bending radius, similar but not the same amount of mechanical damage forms for both bending devices. Additionally, the resistance as a function of cycles also differs after 10,000 cycles. A closer examination of the damage, especially in the Al/Mo film system indicates that the speed of the bending and if the samples experience spring back, can alter the received mechanical damage. The in-situ resistance data was further examined to correlate the evolution of cracks with resistance. The new knowledge gained about how the electrical data delivers mechanical damage information will aid in providing specific failure criteria for flexible electronics. Without specific failure criteria the electro-mechanical reliability of flexible and foldable material systems cannot be properly evaluated.

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