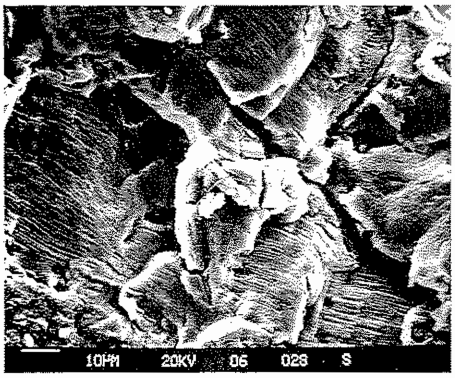


Bild 8: REM-Aufnahme von einer geklebten Schwingprobe mit deutlich ausgeprägten Schwingbruchstrukturen im Aluminiumschaum

Fig. 8: SEM micrograph of an adhesively bonded fatigue specimen with clearly marked fatigue fracture structures in the aluminium foam

4 und 6). Zwischen Zug- und Scherbeanspruchung kann deutlich unterschieden werden. Das Verformungsverhalten der sehr gut plastisch verformbaren Aluminiumschäume unterschiedlicher Dichte, mit herstellungsbedingten, gewollten zahlreichen Hohlräumen, wird durch die Höhe der Wabenränder charakterisiert. Aufgrund der versuchs- und probenbedingten ungleichmäßigen Zugspannungsverteilung, wurden lokal auch Reißwaben im Rißgrund beobachtet. Bei den im Biegeschwingversuch geprüften Proben hinterließ die schwingende Beanspruchung beim Fortschreiten des Risses deutlich erkennbare Schwingstreifen in der Aluminiumschaumstruktur (Bild 8). Der Abstand der Schwingstreifen nimmt mit steigender örtlicher Spannung zu, was mit einem zunehmenden Rißfortschritt einhergeht.

An allen im Biegeschwingversuch geprüften Proben sind deutlich ausgeprägte Schwingstreifen im Aluminiumschaum nachzuweisen. Auffallend sind dabei die unterschiedlich ausgebildeten Schwingbruchstrukturen in Abhängigkeit von der lokalen Beanspruchung/Spannung und den werkstoffbedingten geometrischen Verhältnissen innerhalb des Aluminiumschaumes.

*No shear failures in the aluminium foam were found in any of the specimens.*

*In the bending fatigue tests, when the load was increased to over 50% of the quasi-static bend strength, the roll-clad sandwich plates failed suddenly after only a few load cycles by spalling of the aluminium cover-sheet. In the adhesively bonded sandwich plates, as in the quasi-static test, cracks first appeared in the foam and these spread slowly through the whole thickness of the plate. However, there was no failure of the structure as a whole. Only after still more load cycles did cracks appear in the adhesive layer, which then grew until the cover-sheet became detached, when the structure as a whole failed (figs. 7 and 8). The best behaviour was that of the specimens bonded with PU. The foam-filled round sections failed due to fatigue cracks formed at the outer surface of the aluminium round section. The sections broke without any appreciable macroscopic deformation.*

*Particularly interesting from the standpoint of potential applications is the failure mode in buckling tests. Foam filling of the aluminium round sections prevented buckling almost completely up to high loads. Specimens with integral foam did not buckle, but rather, sheared after failing locally. In the carbon fibre reinforced specimens, individual windings failed in the area of the contact points without buckling or perceptible damage elsewhere in the specimen. This shows that by virtue of the foam/outer section combination, buckling behaviour can be controlled within a wide range.*

*After completion of the aforesaid tests, the specimens were examined visually and by SEM for their fractographic features. Essentially, aluminium/foam composites show fracture- and load-specific micro-fractographic characteristics at the fracture surface between the bonding layer (e.g. cover-sheet/adhesive/foam) and within the foam itself. As with the micro-fractographic evaluation of fractures in solid metallic materials, so too in this case the SEM examinations indicated that the fracture surfaces in the aluminium foam show features from which particular fracture mechanisms can be deduced with certainty. The process of forcible parting in tensile, shear, bend and buckling tests is indicated micro-fractographically by honeycomb structures (figs. 4 and 6). It is possible to distinguish clearly between tensile and shear loading. The deformation behaviour of the very easily plastically deformable aluminium foams of various densities, with their desired numerous hollow spaces produced by the preparation method, is characterised by the height of the honeycomb edges. Because of the non-uniform tensile stress distribution resulting from the nature of the tests and specimens, tear honeycombs were also observed locally at the base of cracks. In specimens exposed to bending fatigue tests the fluctuating load produced clearly recognisable fatigue striations as the crack advanced through the aluminium foam structure (fig. 8). The spacing of the fatigue striations increases with increasing local stress, which is produced as the crack continues to advance.*

*All the specimens tested by bending fatigue show clear fatigue striations in the aluminium foam. In this, a striking feature is the different formation of fatigue fracture structures depending on the local loading or stressing and on the material-dependent geometrical situation within the aluminium foam.*

## Authors

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