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Comment on "The production of electron transparent areas by splat-quenching"

Recently, the author [1] had examined the conditions for the formation of two different electron transparent areas in a splat-cooled foil. The conditions were found to involve either droplet–droplet interactions or droplet–substrate interactions during quenching. The simple spreading of individual droplets into thin regions was not observed, but this mechanism was not eliminated as a possibility. Williams and Edington [2] have noted that the abundance of such thin areas can, to a significant degree, be controlled by varying the splatting conditions. In subsequent observations, the author has also found these "simple spreading" regions. Williams and Edington have also pointed out, as is likely to be the case, that because of the similar conditions under which they are produced, areas formed by the simple spreading mechanism have more reproducible microstructures than those produced through droplet-droplet or droplet-substrate interactions.

It is with regard to the reproducibility of the microstructures that I would like to add a few comments. In work dealing with amorphous Cu–Zr splatted alloys, thin areas presumably produced by simple droplet spreading (i.e. the thin areas were at the edge of the foil) were observed to have amorphous microstructures. However, some of these areas were also observed to have undergone partial crystallization during cooling. This would imply that within areas produced under similar conditions, the cooling rates varied significantly (the slower cooling rates resulting in partial crystallization). Unfortunately, a quantitative assessment of the difference in cooling rates is impossible to make. Nevertheless, it is clear that even similar solidification conditions may lead to significantly different cooling rates (and correspondingly different microstructures) and thus caution must be exercised when comparing the microstructures of gun-splatted foils.

In contrast, using the same Cu–Zr composition but a different splat-cooling technique (the piston and anvil technique [3]), more massive samples were obtained. For microstructural investigations, these "bulk" samples were electropolished. In these thinned foils, the microstructural features were more consistent than in gun-splatted, unthinned foils. By comparing areas within the same general location in the foil, only amorphous regions were observed, with no sign of partial crystallization. Naturally, cooling rates varied to some degree throughout the splats. However, those sections of numerous different splats in which the cooling conditions were optimal (as determined visually by the degree of oxidation, surface smoothness, etc) showed consistent, reproducible results in the form of completely amorphous microstructures.

Thus, in conclusion, although thin areas produced by a simple spreading mechanism in which the solidification conditions are similar probably have more reproducible microstructures than in areas produced by droplet–droplet or droplet–substrate interactions, even these areas need not have the same structural features. Probably the most reproducible and consistent microstructures can be obtained by thinning splat foils produced in a more massive form.

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Comments on "Contoured double cantilever beam specimens for fracture toughness measurement of adhesive joints"

Mai [1] introduces some confusion regarding the design and use of contoured double cantilever beam (CDCB) specimens which should be clarified. The major confusion with respect to this work centres about the use of the CDCB specimen in a range of crack lengths beyond the linear compliance region. Equation 1 is only applicable over the linear region. When the uncracked ligament, $(w-a)$ or b is too short, the back end of the specimen begins to control the compliance. This begins to occur when:

$$1.25\,h \leqslant b \leqslant 1.5\,h,$$

and whenever b is less than h, only the back end controls.

Unfortunately, the paper was quite difficult to understand because of nomenclature and definitions peculiar to this paper and different to those used in commerce (ASTM) for metallic systems as well as adhesives.

Mai's equation 3 states:

$$R = -\frac{U^2}{2t}\frac{\partial}{\partial a}\left(\frac{x}{U}\right) = -\frac{U^2}{2t}P; \quad \text{for} \quad a > 3\,\text{in.}$$

This equation comes from Gurney and Hunt [2] which is a 1971 reference. In an earlier (1960) paper by Irwin [3] this expression for unit thickness is given as:

$$\left(\frac{\partial U}{\partial c}\right) = \mathcal{G} = \frac{1}{2}\frac{F}{M}\left(\frac{\partial F}{\partial c}\right)_{e\ \text{fixed}},$$

where F is the force $= Me$, e is elongation, c the crack length, M the spring modulus, U the total energy, $(\partial F/\partial c)$ the rate of change of force with crack length, and $\mathcal{G}$ the strain energy release rate. Therefore, in terms of thickness, B, we can rewrite the above equation

$$\mathcal{G} = \frac{e^2}{2B}\frac{\partial M}{\partial c}.$$

Common nomenclature today would be:

$$\mathcal{G} = \frac{\Delta^2}{2B}\frac{\partial(1/C)}{\partial a},$$

where Δ is the displacement of the load, C the compliance $= 1/M = \Delta/P$, and a the crack length.

Converting Mai's paper to common nomenclature we see: $W = \Delta$, $t = B$, $X = P$, $P = [\partial(1/c)/\partial a] =$ constant. We believe it would have been less confusing to use standard ASTM E-24 nomenclature and to reference the work which provides the insight for the body of work known as fracture mechanics.

In addition to the two areas mentioned above, there are a number of confusing and either incomplete or wrong statements made in the text. Mai's Equation 1 reads:

$$R = \frac{4X^2}{Et^2}\,m \qquad (1)$$

where X is the fracture load, and t the adhesive thickness; and his Equation 2 reads:

$$m = \left(\frac{3a^2}{h^3} + \frac{1}{h}\right) \qquad (2)$$

where h is the height of the beam at a given crack length.

In an explanation of this equation, Mai points out that m is exact for slender CDCB adherends, but not correct for stiff ones ($m = 90$ versus $m = 4\,\text{in.}^{-1}$). He then states a modified Equation 1 based supposedly on crack tip effects and departure from beam theory:

$$R = \frac{4X^2}{Et^2}\,m'.$$

It should be pointed out that only the equation derived from compliance measurements (using m')