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Shock and ballistic properties of bainitic steels and tungsten alloys

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This dissertation reports the shock and ballistic properties of a selection of bainitic steels. In order to attain these data a number of experimental techniques were developed and the dynamic properties of two sintered tungsten alloys were measured.

The shock properties of the two bainitic steels considered in this research were found to be similar, there were however some important differences. Whilst the upper bainitic samples were recovered either whole or in a few fragments, the lower temperature bainite exhibited a great deal of brittle fracture. A very interesting difference was that while the ferrite in the lower temperature bainite underwent a pressure induced phase transition at 13 GPa as would be expected in a low alloy steel, the upper bainite did not appear to. Whether the phase transition has in fact been suppressed or so fast as to be non-observable is discussed in this dissertation. Given the only difference between these two alloys is microstructural, this must be the overriding factor in whether this characteristic transition is observed.

Using both classic and symmetric Taylor tests, two sintered tungsten alloys were characterised, remarkably, tensile surface strains of almost 5 % were recorded. These materials are under consideration as an environmentally friendly penetrator material, a replacement for the depleted uranium currently used, making them ideal projectile material for this study of the ballistic properties of potential and current armour steels.

Ballistics experiments were performed in order to compare one of the bainitic steels with both an existing armour steel and also to mild steel using tungsten penetrators. The existing armour steel exhibited a 'plugging' behaviour. The bainitic steel failed by a combination of the 'plugging' mechanism and fragmentation.

The bainitic steels under consideration in this research are potential replacements for the current more expensive steels that are used on armoured vehicles. Whilst this study does not try to conclude whether they do in fact offer more protection than existing products to such vehicles, it does provide sufficient data for modellers to help make informed decisions.

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