Friction and lubrication effects in the machining of aluminium alloys

Abstract

Friction between the rake face of a cutting tool and the freshly formed chip surface plays a vital role in influencing both the ease of cutting and the quality of the resultant machined surface. The existence of clean metallic surfaces together with the high local hydrostatic stresses favour the formation of strong adhesion between the cutting tool or insert and the machined component. These adhesive bonds can lead to poor surface integrity although their extent can be limited by the provision of a suitable machining lubricant. In an effort to identify the essential lubricating aspects of fluid activity, as opposed to any role as a coolant, experiments have been carried out involving the orthogonal machining of precipitation-hardened aluminium alloys, principally Al 2014, in controlled, low-pressure gas environments in which the feed (i.e., the depth of cut) speed and temperature have been varied while using a variety of tool materials and lubricating species. The results indicate that there can be unexpectedly subtle, but significant, interactions between the metallurgy of the workpiece, the nature of the surface of the tool and the surrounding environment. These are not wholly consistent with conventional theories of vapour phase lubrication in which transport of the lubricant has been assumed to control the effectiveness of the lubricating agent. The implications of these observations for the complex tribological system constituted by the combination of workpiece, tool surface and local environment are discussed.