Tool Rake Face Temperature Distribution by Near Infrared Thermography While Using YAG Tools to Machine Ti6Al4V

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Ti6Al4V is the most commonly used titanium alloy in the aerospace, automotive, chemical, and biomedical industries. The alloy is attractive due to its high strength to weight ratio, corrosion resistance, and compatibility with the human body. However, the alloy has poor machinability due to severe abrasion, which leads to short tool life. Among efforts that have been undertaken to optimize the machining of this alloy stands out the use of computer simulations. These simulations may allow determination of process conditions that result in longest tool life. To be useful, however, these models have to be validated experimentally. Typically, model validation involves the measurement of cutting forces and chip thickness, and neglects critical outputs such as tool temperature and its distribution. Out of these neglected outputs, the temperature distribution at the tool rake face is the most difficult to obtain, since normally this face is not accessible to the necessary instruments. During the course of the research to be presented herein, access to the tool rake face was obtained with the use of optically transparent, very hard Yttrium Aluminum Garnet (YAG) cutting tools. A novel technique, called near infrared thermography was implemented to measure the full field distribution of the rake face temperature while machining Ti6Al4V over a wide range of conditions spanning industrially typical speeds and feeds. The expectancy is that the data can be used to produce better machining models for process optimization. The YAG tool wear performance was evaluated to obtain preliminary data about their potential as an industrial cutting tool material. It was found that peak temperature along the tool rake face is in the order of 1000°C and occurs at a distance from the cutting edge of 1 to 1.5 times the feed. It was also found that after half a meter of cutting the depth of the crater on the tool rake face formed by wear is typically less than 10 micrometers.