# Mechanical Engineering
## PhD Completion Seminar

THE UNIVERSITY OF MELBOURNE

SEMINAR SERIES 2008


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Monday 21st January, 3pm
Theatre E1 , Level 3
Building 170
Mechanical Engineering

# Micromechanical properties of hydroxyapatite coatings using nanoindentation techniques.


Hydroxyapatite is used extensively in orthopaedic application, but little is known about the mechanical properties. Such information is important to understand the strength, abrasion resistance, fracture toughness and stiffness of implant materials. The non-homogeneity of porous, graded or layered hydroxyapatite structures requires analysis at the microscale. Nanoindentation is the most suitable technique that has been applied to coatings produced by thermal spraying hydroxyapatite. Coatings produced from solidified droplets of three different sizes (small, medium and large) were characterized. Flame sprayed hydroxyapatite coatings (cross-section and top surface) are extensively characterized using a series of techniques, including X-ray diffraction (XRD), micro-Raman, micro-topography, scanning electron microscopy (SEM) and Scanning Line Analysis.

It is found that micromechanical properties of the top surface of polycrystalline thermally sprayed HA are slightly higher than those of the cross-section. To confirm the obtained results, micromechanical properties of a single HA crystal is measured using nanoindentation techniques. Nanoindentation data reveal slightly higher micromechanical properties of a-axis than c-axis.

To fully understand the HA coatings, the most obvious approach is to consider a single solidified droplet. Therefore, attention is focused on one single solidified droplet. The critical and maximum load that a single splat can tolerate is measured, as well as the micromechanical properties i.e. hardness and elastic modulus. The effect of substrate pre-heating temperature on micromechanical properties is also considered. Single droplets are deposited on a Ti substrate at room temperature (RT) and 350°C. Results show the considerable difference in micromechanical properties between these two droplets. The observed cracking threshold for RT is higher than that of the 350°C droplet, which can be attributed to the existence of compressive surface residual stresses. Compressive residual stresses overestimate hardness; therefore, a higher hardness value is expected for the RT sample. Nanoindentation data reveal slightly lower hardness for RT than 350°C. The dominant mechanism responsible for the different microstructure and micromechanical properties in deposited droplets at different substrate's temperatures has not yet been fully identified. Experiments are underway to determine whether the difference arises from the quenching stresses, cooling stresses, changing of the thermal expansion coefficient of the coatings and the substrate at high temperature, amount of un-melted or partially melted HA within the droplet, porosity within the droplet, or other effects in these single solidified thermally sprayed droplets. Residual stresses measured by nanoindentation techniques compare favourably with the accepted method for measuring residual stresses, X-ray diffraction.


MORE INFORMATION

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