MANUFACTURING SUB-MICROMETER-SIZED AND NANOMETER-SIZED COATINGS IMPLEMENTING THERMAL SPRAY ROUTES

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motivation

M. GELL Mater. Sci. Eng. 204(1) (1995) 246-251
H. HAHN et al. Nanostruc. Mat. 9 (1997) 603
N.B. DAHOTRE et al. Surf. Coat. Tech. 194 [1] (2005) 404

the pioneer: R. McPherson

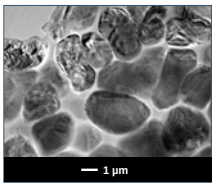
In 1973, **Pr. R. McPherson** showed that alumina plasma-sprayed coatings consisted of layered splats with a columnar structure where **column diameters were in the range of 100 to 300 nm**, average values, depending upon the spray conditions (***R. McPherson***, *Formation of metastable phases in flame and plasma-prepared alumina, Journal of Materials Science, 8 (1973) 851-858*).

Later on, he and Gani studied the **formation of nanometer-sized particles** by RF plasma processing (***M.S.J. Gani***, ***R. McPherson***, *Crystallization of mullite from Al_2O_3-SiO_2 glasses, Journal of the Australian Ceramic Society, 13(2) (1977) 21-23*).

Those pioneering works demonstrated that **thermal spray processes are able to generate nanometer-sized features and process nanometer-sized particles**.

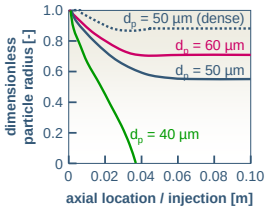
by spraying agglomerates made of nanometer-sized particles

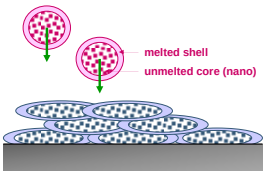
FEEDSTOCK



Al_2O_3-30ZrO_2 feedstock
40 µm average diameter

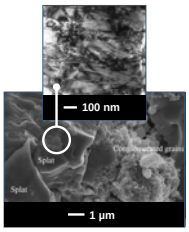
PROCESS



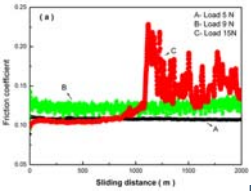


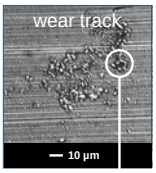
R.S. Lima, B.R. Marple
Mat. and Design 29 (2008) 1845-1855

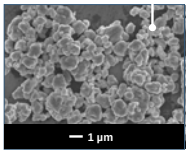
STRUCTURE



COATING PROPERTIES







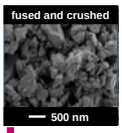
the feedstock lower thermal conductivity (*i.e.*, voids and thermal resistance) requires specific operating parameters optimization

partially molten particles (to retain the "nano" structure) lead to the formation of a two-scale coating structure typified as "bimodal"

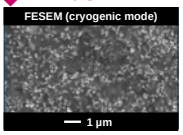
bimodal structured coatings exhibit superior tribological performances compared to µm-sized structured coatings

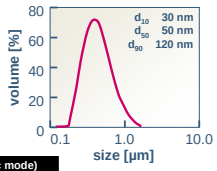
by spraying a suspension made of nanometer-sized particles

FEEDSTOCK

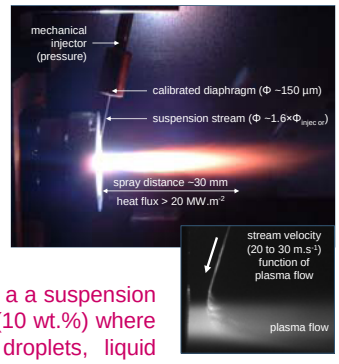


+ Et-OH



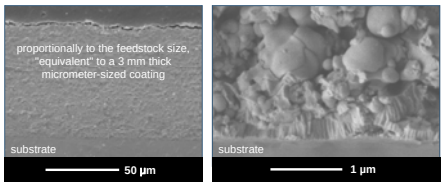


PROCESS

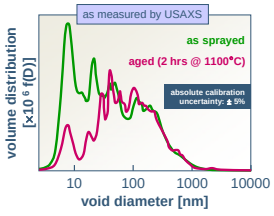


injection in a thermal plasma flow of a a suspension made of nanometer-sized particles (10 wt.%) where it encounters fragmentation into droplets, liquid phase vaporization and particles processing

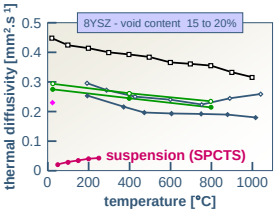
STRUCTURE



coating: columnar layer and a granular layer
void sizes: from 1 to 1000 nm



COATING PROPERTIES

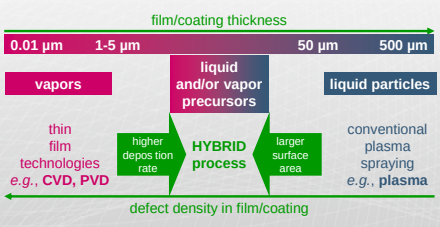


micrometer-sized
- **Wang** (*Thin Sol. Films*, 2006)
- **Zhou** (*Scripta Mat.*, 2004)
- **Huang** (*J. Europ. Cer. Soc.*, 2003)

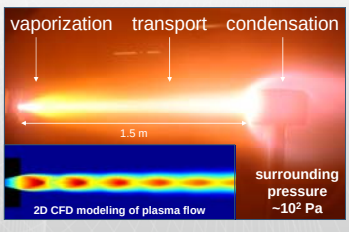
nano + micrometer-sized
- **Zhou** (*Scripta Mat.*, 2004)
- **Huang** (*J. Europ. Cer. Soc.*, 2003)
- **Lima** (*Mat. Sc. Eng.*, 2008)

by vaporizing feedstock particles and condensing vapors

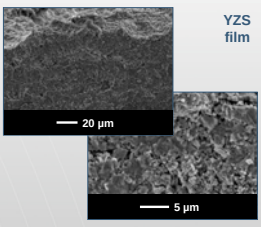
BASELINE AND OBJECTIVE



PROCESS

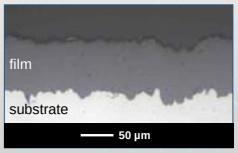


STRUCTURE



FILM PROPERTIES

YZS film gastight to H_2 for pressures up to 4x10^5 Pa



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