Thermal stability and solid state dewetting of thin films and coatings

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We report the results of our studies of solid state dewetting (agglomeration) of thin Au, Fe, and Ni films, of Au-Fe, Ni-Fe and Ni-Pt bi-layers, and of Ni-Cr-Ni and Ni-Au-Ni "sandwiches" deposited on sapphire substrate. At the final stages of agglomeration an array of single crystalline faceted nanoparticles is produced. We demonstrate an extraordinary thermal stability of these nanoparticles and correlate it with the absence of crystalline defects (dislocations and grain boundaries) in the particles, and with their faceted shape. Furthermore, we demonstrate that a synergistic interplay of surface diffusion, bulk interdiffusion, and diffusion along the metal-ceramic interface determines a final outcome of dewetting process. We demonstrate that stress-induced hillock formation is closely associated with the intermediate dewetting stage and outline the "marker" method that has enabled us to identify the growth mechanism of the hillocks. Finally, we discuss how the thermal stability of thin films and coating can be manipulated with impurities.