Mechanical properties of d.c. magnetron-sputtered and pulsed vacuum arc deposited ultra-thin nitrogenated carbon coatings

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Nitrogenated carbon coatings (CNx) are widely used as protective coatings on magnetic hard disks. In this paper, the mechanical properties of such coatings produced with d.c. magnetron-sputtering and filtered high-current vacuum arcs (HCA) are compared. An AFM-based scratching technique has been used that allows the generation and characterization of scratches with residual depths in the Å range. With this technique, the very beginning of plastic deformation and the scratching resistance of ultra-thin coatings (5 nm) can be investigated. The scratching resistance of different sets of films was compared to Raman spectra, X-ray photoelectron spectroscopy (XPS) and surface acoustic wave (SAW) measurements. For samples with a higher resistance against mechanical penetration on a sub-nanometer scale, a higher Young's modulus and a downshift of the Raman G and 700 cm−1 peak position was observed. It turned out that for magnetron-sputtered films, the resistance against mechanical penetration increases with higher nitrogenation, whereas the films produced by HCA show an inverse tendency. The scratching resistance and the Young's modulus of HCA films decrease nearly linearly with increased deposition temperature.