ABSTRACT

Tetrahedral amorphous carbon (ta-C) is a very promising material for biomechanical and industrial applications because it is chemically inert, biocompatible and extremely hard. Our experiments show that with ta-C the wear resistance of hip implants can be improved by a factor of one million when compared with common commercial ones. The poor wear resistance limits the lifetime of currently available hip implants to 5-15 years, which is below the life expectancy of the average patient. The extreme physical properties of ta-C also make it suitable for various industrial applications. In our experiments with paper mill sensors and water jet cutters, ta-C coating on contact surfaces significantly reduced wear and accumulation of resin. Moreover, with ta-C it was possible to measure higher paper coating paste shear rates ($10^7$ 1/s) than with any other material used in paper paste viscometer nozzles.

These applications have become feasible because we have solved the problems related to the adhesion of ta-C. To overcome the adhesion problems due to the internal stress of ta-C, one needs good control over plasma energy. We have developed a new optical method to measure the plasma energy and a simple adhesion and quality evaluation method that tests the deposition process as a whole. These combined with the possibility to adjust the plasma energy allow us to deposit thick (>10 µm) ta-C coatings necessary for demanding industrial and biomedical applications.