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COMPOSITIONAL DEPENDENCE OF HARDNESS AND MODULUS OF SINFEC COATINGS

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Summary: Total hip replacement is a largely successful procedure where the implants have a survival rate of at least 95% after 10 years. The main limiting factors include release of ions and wear debris from the implant materials. Coating the implant metal parts with a ceramic coating has been suggested as a way to decrease the wear rate and the metal ion release, thereby increasing the implant lifetime. Promising candidates include silicon nitride based coatings due to their wear resistance, biocompatibility and particle solubility. Incorporating carbon and iron could reduce oxygen contamination and be a means of adjusting the dissolution rate and mechanical properties, while maintaining biocompatibility.
In this work, angled targets of silicon, iron and carbon were sputtered using nitrogen as a reactive gas to create compositional gradients, on silicon wafers. During deposition the pressure was 3 mTorr, the argon gas flow was 10 sccm and the nitrogen gas flow 3 sccm, resulting in a ratio *f*N2/Ar of 0.3. The silicon target was powered by a pulsed DC aggregate with 200 W, 200 kHz and 2 µs while the iron target and carbon target were powered by DC aggregates with 25 W and 65 W, respectively. The coating composition was evaluated with ERDA, the surface roughness with AFM, the coating thickness was measured in SEM, and hardness and modulus was determined with nanoindentation. Each method was used in five points composed of the four corners in a square (40mmx40mm) and the middle point.

The ERDA results show gradients with silicon contents from 26 to 34 at.%, iron content from 10 to 20 at.% and carbon content from 8 to 14 at.%. The nitrogen content also varied from 40 to 46 at.% and the oxygen impurities were low (0.3 to 0.6 at.%). The thickness ranged from 470 to 630 nm and the cross-sectional morphology was slightly columnar. The hardness and modulus obtained with nanoindentation were between 13.9 and 18.1 GPa and 203 and 224 GPa, respectively. All five examined points had a low surface roughness as well as a high hardness and modulus, making them promising for further investigation.