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Protective Titanium Adlayer Acting as Silver Diffusion Barrier

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Statistics from World Health Organization show that cardiovascular diseases are beside cancer the leading cause of death globally. More than 75% of all cardiovascular diseases are due to coronary heart disease (heart attack) and cerebrovascular disease (stroke). Electrocardiogram (ECG) recordings are known to provide prognostic information for cardiovascular diseases and mortality. For medical diagnosis electrocardiography is only a powerful predicting tool measuring over a long period enabling a statistic evaluation in different physical stress situations (sleep, work, sport) with simultaneous remote-diagnosis. For an ECG electrode Ag/AgCl gel electrodes are commonly used, which are suitable for short-term heart observation. If used for long-term, however, they are facing the problem of drying out and subsequently causing skin irritation. Hence, silver-coated yarn with titanium adlayers using magnetron sputtering was investigated for body electrode applications.
Pure silver surfaces react with hydrogen sulphide in air leading to tarnishing and with oxygen dissolved in aqueous solutions resulting in Ag ion release. While the latter is responsible for the antibacterial properties, a high Ag release can also yield an undesirable cytotoxic effect. A passivation is thus required that does not change the electrical and optical properties, but limits Ag sulfidation and its ion release. The depositions of an ultrathin metal titanium film as passivating adlayer were examined using magnetron sputtering. The naturally formed titanium oxide and the Ti/Ag interface are investigated for their stability in humid and aqueous environments using XPS depth profiling. Ion release measurements show an efficient control over the release properties depending on the thickness of the Ti adlayer. Initial burst release of the pure metal Ag surface can be avoided by a 2-15 nm thick overlayer that also prevents tarnishing and maintains the electrical properties. Such electrically conductive fibers are, e.g., used as body electrodes for long-term ECG measurements, in which the TiOx passivation avoids cytotoxic conditions for moistened electrodes.

Keywords
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