Abstract #598 | Invited

High-power pulsed sputtering for the smart design of coatings and nanoparticles

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Sputtering using high-power electric pulses is a way to significantly increase the plasma density and thereby increase the ionization probability of the atoms generated by the sputtering process. This is of obvious interest since the film forming species, now ions rather than atoms, can be tuned in respect of energy and direction using electric and/or magnetic fields for the design in materials and coatings for different engineering needs.

The use of high-power pulses in magnetron sputtering (HiPIMS) was introduced in the end of the 1990th [1] and is now increasingly adopted for high-end coatings by industry. HiPIMS are especially useful for improving film adhesion, improving film density, tuning stress levels and deposition of complex shaped substrates. To achieve full effect of the ionized deposition proper biasing of the substrate is mostly needed. For example, time-shifted pulsed bias can be utilized to energize and select a desired portion of ions for energetic bombardment because different ions are created during different parts of the plasma pulse. [2]

The pulsed nature of the plasma can also be used for characterisation and tuning of the sputtering processes, such as for reactive sputtering. The current response of the applied voltage pulse is largely dependent of the composition of the sputtering plasma and the composition of the sputtering target. In some cases, there is a simple relation between the amount of reactive gas supplied and the peak current, [3] however, also with a complicated relation between current response and chemistry accurate control of the process can often be obtained. [4]

High-power pulses can also be utilized in non-magnetized sputtering. An example is hollow cathode sputtering (HCS). We have used HCS in high sputtering pressures (100 Pa) to achieve the direct opposite effect, of that for HiPIMS, porous coatings consisting of loosely connected nanoparticles. Nanoparticles can efficiently be grown in the gas phase since they obtain a negative floating potential in the plasma. This potential will facilitate an effective collection of positive ions in the plasma by the growing particle. [5] Collecting these nanoparticles on a substrate a porous coating is form. consisting of an extremely large surface area. These porous coating are of great interest as catalytically active electrodes in electrochemical devices such as fuel cells and electrolyzers for a sustainable energy systems.

Affix

References

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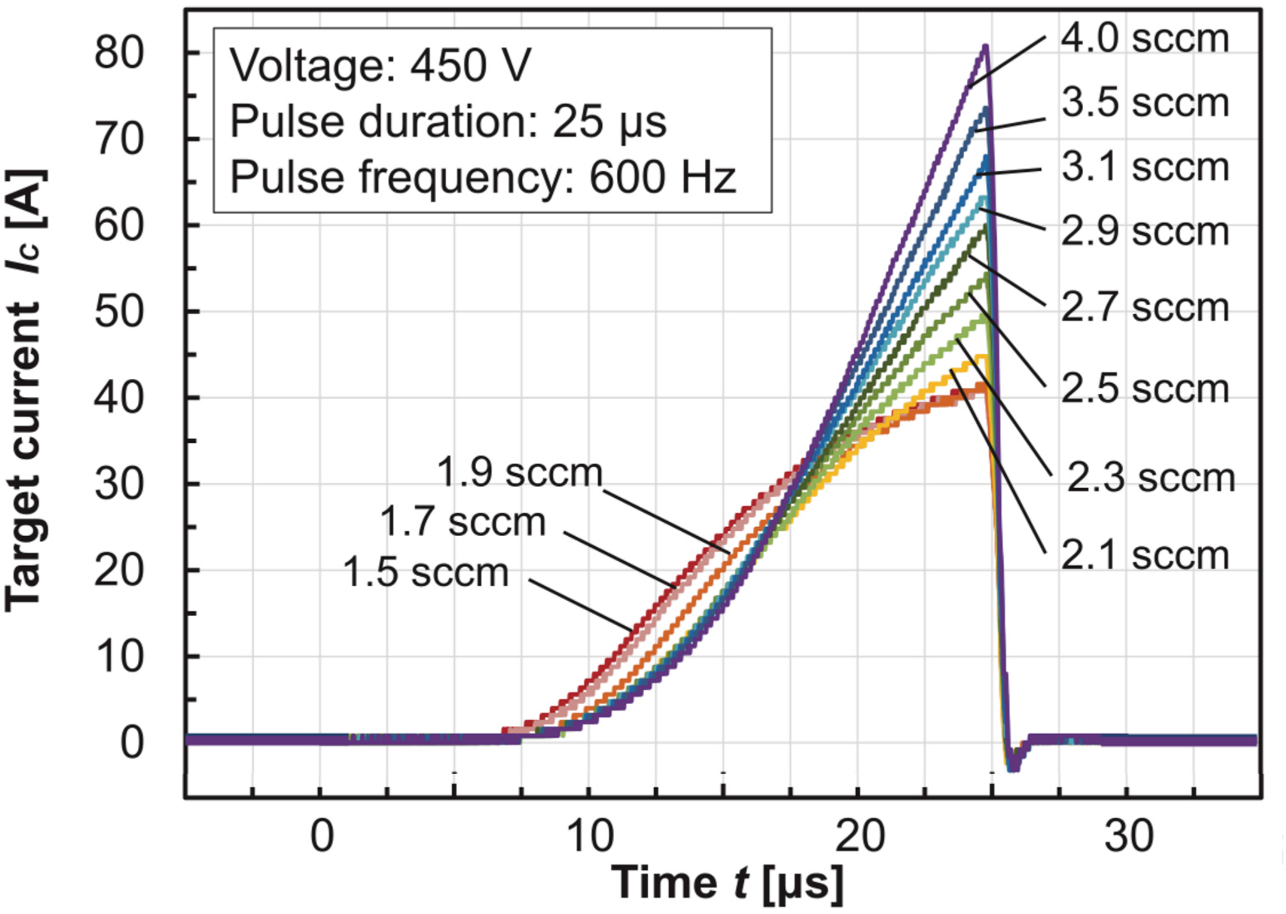
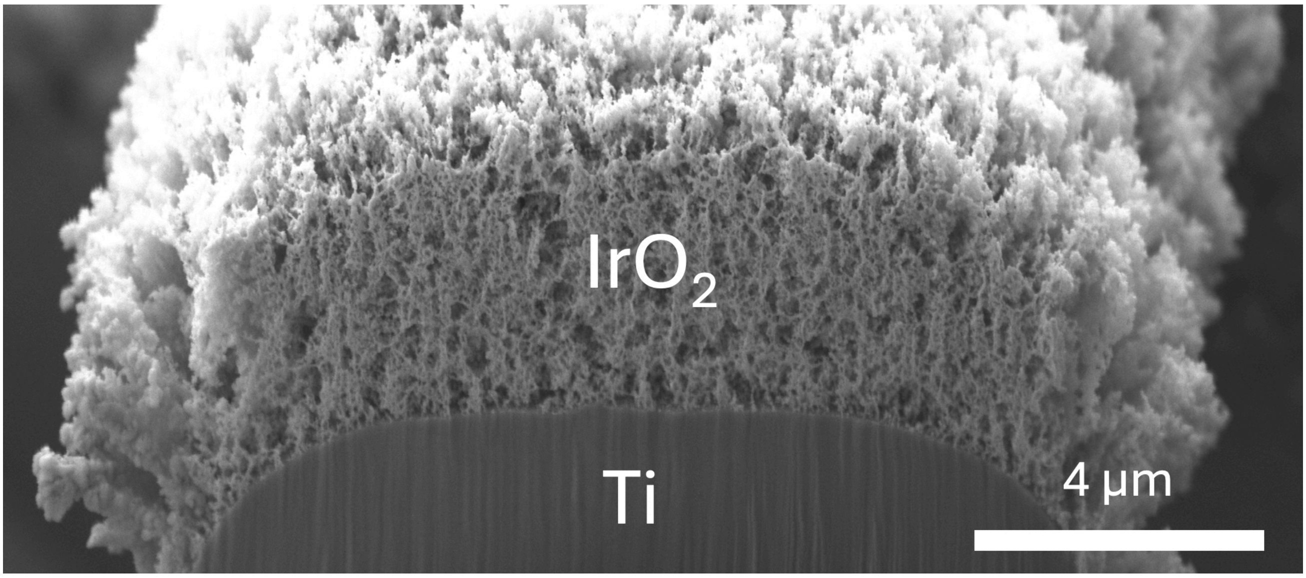


Reactive HiPIMS

The figure illustrates the current responsibility from a HiPIMS voltage pulse as a function of the flow rate of the reactive gas, N_2 during sputtering of a Hf-target. It is clear that the peak maximum can be used for process control. [3]



Catalyst for water splitting

A cross-sectional view of catalytically active IrO_2-nanoparticles deposited on a fibrous Ti substrate.