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Field-emission investigations of micro-structured stainless steel ASTM 304

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Highly-alloyed chrome-nickel stainless steel is the most important material in vacuum technology. Especially in high and ultra-high vacuum technology it is used for vacuum chambers and components. One of the main research focuses before 2005 [1] was the study of parasitic field emission (FE) of specially treated stainless-steel surfaces for applications in accelerator technology. The measured threshold field strength is about $25 \dots 30 \text{ V}/\mu\text{m}$ for 1 nA [2]. An important cause of field emission enhancement is the grain boundary structure. Therefore, stainless steel (ASTM 304 or 1.4301) was wet-chemical micro-structured and investigated with respect to field-emission properties. Some selected results are:

1. Threshold field strengths of micro-structured stainless steel are in the range of $7 \text{ V}/\mu\text{m}$ for 1 mA (is better than [3], but CNT field emitter has $1 \dots 2 \text{ V}/\mu\text{m}$ [4]).
2. For application as FE cathodes in vacuum components (cylindrical surfaces [1]), very large cathode arrays of a few cm^2 can be produced cost efficiently.
3. Very large cathode arrays with lower current density ($\leq 30 \mu\text{A}/\text{cm}^2$) are field emitter with long-term stability. However, the main objective is the substitution of thermionic cathodes in vacuum electronic applications.

References

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