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WIRE ELECTRODE WITH A STRUCTURED INTERFACE SURFACE

DESCRIPTION

The invention relates to a wire electrode for spark erosion cutting of metals, electrically-conducting ceramics etc., comprising either a homogenous centre made of a metal or of a metal alloy, or a composite centre and comprising at least one sheath coating which wears during erosion.

When using wire electrodes it has been shown that wire electrodes comprising sheath coatings, wherein the sheath coating for example comprises β -brass or γ -brass, have a better cutting performance than electrodes without such sheath coatings. This is due to the fact that the β/γ -sheath coating comprises a high zinc content which is embedded in the microstructure. Such wire electrodes comprising β -brass sheath coatings or γ -brass sheath coatings have a disadvantage in that the sheath coating with its cubic body-centred lattice is significantly less well deformable than the centre which usually comprises a cubic face-centred α -brass. This results in the surface of such a sheath electrode ripping up in sections. During this process, cracks form which, as has been shown in investigations, have a certain advantage in some respect, because this obviously supports clearing the cutting gap. Consequently, in the case of higher workpieces, improved cutting performance is achievable with such electrodes comprising a rough surface. Such wire electrodes are however associated with a disadvantage in that due to the irregular and fissured hard surface, both guidance of the wire and current conduction to the wire, are impeded. Such a sheath coating is very rough and hard, so that guides wear relatively quickly. Furthermore, vibrations in the wire are generated which also further impede current conduction. These vibrations are also disadvantageous for



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guiding the wire in the gap because the wire electrode is excited to produce oscillations which can lead to short circuits.

It is the object of the invention to improve a wire electrode of the type mentioned in the introduction so that the advantages of improved cutting performance obtained by the fissured surface of the sheath coating, are maintained, without the disadvantages of diminished current transition and increased wear and increased oscillations in the wire, having to be accepted. It is a further object of the invention to provide such an electrode with a surface structure which leads to a further improvement in performance.

According to the invention, this object is met in that the surface of the outer sheath coating is structured and in that the indentations created by the structure are filled in with a filler comprising an easily vapourable metal or a metal alloy for obtaining a surface with a short peak-to-valley height and thus little surface roughness.

If the fissures in the sheath coating, created during the manufacture of coated wire electrodes, are filled in with an easily vapourable metal or a metal alloy comprising zinc or a zinc alloy, with the zinc fraction in the alloy being significantly above the zinc fraction in the sheath coating, then a wire electrode with a smooth outside surface is obtained which can be transported in the wire guides with only slight wear, wherein the entire contacting surface can be used for current conduction, with irregularities which can cause vibrations and which impede current conduction, being avoided. In this way it is possible to considerably increase the current feed to the electrode. During the subsequent erosion process in the cutting gap, the filler which is present in the fissures or grooves is used up first so that along most of the length

of the cutting gap a sheath coating is available for the erosion process, which sheath coating comprises a strongly fissured surface. As a result of this fissured surface, the discharge of the eroded material is improved while at the same time field intensity peaks and thus locations of increased discharge probability and associated with this an increase in the discharge frequency, are generated by the projections.

During normal manufacture of wire, during which due to the different deformation behaviour of centre and sheath coating, fissures are produced in the sheath coating, the above-mentioned locations with increased field intensity peaks are generated purely at random. However, if the surface of the sheath coating comprises grooves which can be shaped so as to be longitudinal, transverse, helicoidal or intersecting, then such locations with an increased discharge probability are provided. This significantly accelerates the erosion process also for the reason that here there is a significant increase in the probability of discharge not occurring in the crater of a discharge which has been generated shortly beforehand. Thus, an even discharge distribution is achieved as a result of the structured surface. At the same time this results in a reduction in the risk of the wire breaking. These grooves or indentations are at least 2 μm in depth and at most 50 μm in depth.

A further advantage achieved, namely that of preventing local discharge accumulation, consists of the discharges being more often enclosed by a liquid dielectric instead of a gas bubble. As a result of the associated more pronounced contraction of the plasma channel, there is greater materials removal per discharge, which clearly has a positive effect on the cutting performance of the wire electrode.

Fig. 1 shows a diagrammatic representation of a cross section of a wire electrode according to the invention, Fig. 2 shows a lateral view of the wire electrode with the structured surface being exposed; and Fig. 3 shows a perspective view of the completed wire electrode.

In Fig. 1, reference no. 1 denotes the centre of the wire electrode, said centre can comprise copper, brass or a composite electrode which can for example have a steel core surrounded by a copper coating. Applied to this centre 1 is a sheath coating 2 whose surface is structured. In Figs. 2 and 3, this structure is a helicoidal structure. This helicoidal structure can also be made with a significantly increased lead, with indentations which extend up to perpendicular to the wire axis. After completion of the sheath coating 2 with the structured surface, for example made of a β -brass, the indentations 3 in the sheath coating 2 are then filled in by filler 4 made of a metal or a metal alloy, said filler 4 being made from a γ -brass comprising a high zinc content, or from pure zinc. Furthermore, it is also possible to use zinc alloys comprising more than 90 % zinc. It is only necessary that this filler 4 evaporates very quickly during the erosion process so that the structured surface of the actual sheath coating 2 is available for the subsequent erosion process.

The peaks between the indentations form locations of increased field intensity so that there is a very good probability that discharge takes place at these peaks. This leads to a spatial distribution of the subsequent charges, so that there is a very good probability that these discharges are more frequently surrounded by a liquid dielectric. At the same time, removal of the eroded material is improved as a result of the structure of the surface. A knob-like structure of the surface of the sheath coating has been shown to be particularly advantageous.

LIST OF REFERENCES

- 1 Centre
- 2 Sheath coating
- 3 Indentations
- 4 Filler

CLAIMS

1. A wire electrode for spark erosion cutting of metals, electrically-conducting ceramics etc., comprising either a homogenous centre (1) made of a metal or of a metal alloy, or a composite centre, and comprising at least one sheath coating (2) which wears during erosion,

characterised in that

the surface of the outer sheath coating (2) is structured and in that the indentations (3) created by the structure are filled in with a filler (4) comprising an easily vapourable metal or a metal alloy for obtaining a surface with a short peak-to-valley height.

2. The wire electrode according to claim 1, characterised in that the filler (4) comprises zinc or a zinc alloy.
3. The wire electrode according to claim 1 or 2, characterised in that the filler (4) comprises a γ -brass.
4. The wire electrode according to one of claims 1 to 3, characterised in that the indentations are larger than $2\text{ }\mu\text{m}$ and smaller than $50\text{ }\mu\text{m}$.
5. The wire electrode according to one of claims 1 to 4, characterised in that the indentations (3) are approx. $15\text{ }\mu\text{m}$.
6. The wire electrode according to one of claims 1 to 5, characterised in that the surface of the wearing sheath coating (2) comprises longitudinal grooves.

7. The wire electrode according to one of claims 1 to 5, characterised in that the surface of the wearing sheath coating (2) comprises transverse grooves.
8. The wire electrode according to one of claims 1 to 5, characterised in that the surface of the wearing sheath coating (2) comprises spiral grooves.
9. The wire electrode according to one of claims 1 to 5, characterised in that the surface of the wearing sheath coating (2) is knob-shaped.
10. The wire electrode according to one of claims 1 to 9, characterised in that the sheath coating (2) predominantly comprises β -brass, wherein the fraction of β/β' -phase in the sheath coating is at least 60 %.
11. The wire electrode according to one of claims 1 to 9, characterised in that the β -brass sheath coating (2) comprises at least 90 % β/β' -phase.
12. The wire electrode according to one of claims 1 to 11, characterised in that the centre (1) comprises copper or brass.
13. The wire electrode according to one of claims 1 to 11, characterised in that the centre (1) is a composite centre comprising a steel core with a copper coating or brass coating.