

Formation of thick metal layers by vacuum-arc plasma condensation

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The possibility of thick refractory metal layer formation by depositing the condensate from the cathodic discharge plasma has been shown in experiment. The vacuum arc plasma source and experimental unit developed to that end provide deposition of multilayer condensates of refractory metals onto cylindrical model substrates of up to 100 mm in dia. and up to 200 mm in height at a rate up to 30 μm/h with thickness non-uniformity less than ±5 %. Thick 2 mm condensates consisting of alternating molybdenum and niobium layers have been prepared.

Экспериментально показана возможность формирования толстых слоев из тугоплавких металлов методом наращивания конденсата осаждением из плазмы дугового разряда в вакууме. Разработанные для этой цели вакуумно-дуговой источник плазмы и экспериментальная установка обеспечивают осаждение многослойных конденсатов тугоплавких металлов на цилиндрические подложки-модели диаметром до 100 мм и высотой до 200 мм со скоростью до 30 мкм/час с неравномерностью по толщине не более ±5 %. Получены конденсаты из чередующихся слоев Mo и Nb толщиной до двух миллиметров.

Vacuum-arc coating deposition techniques [1] deal as a rule with relatively thin layers of materials to be deposited, most often less than 20 μm. In these cases, the process duration is of 1 to 3 h, including the time required to attain the operating vacuum. As to manufacturing of much thicker (by 1 to 3 decimal orders) layers, the vacuum arc technique was believed to be substantially unsuitable until recently. At the same time, it is known in the art that the vacuum arc method is the only way to solve some problems of this kind. Then, when tasks of sufficient importance are to be attained, economic considerations become relegated to the background. This is valid, in particular, in manufacturing of some tubular pieces, such as rocket engine nozzles. In many cases, the material of those should consist of alternating layers of two refractory metals (Mo and Nb, Nb and Ta, etc.).

This work deals with experiments on deposition of alternating Mo and Nb layers onto steel and graphite substrates at the condensate total thickness of 1.5 to 2 mm.

The plasma source as the main tool to apply such "thick" coatings (in contrast to usual vacuum-arc deposits) must provide, among other properties, high reliability ensuring stable prolonged operation and a high condensate deposition rate. The commonly used source with magnetic focusing [2], when being tested in the prolonged arc burning mode, exhibits a drawback consisting in the condensate accumulation on parts adjacent to the cathode, namely, on the arc-firing device, screens, and anode. This, in turn, results in shorting of electrodes causing severe consequences. The only way to