Can the noble metals (Au, Ag, and Cu) be superconductors?

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It is common knowledge that noble metals are excellent conductors but does not exhibit superconductivity. On the other hand, quantum confinement in thin films has been consistently shown to induce a significant enhancement of the superconducting critical temperature in several superconductors. It is, therefore, an important fundamental question whether ultra-thin film confinement may induce observable superconductivity in non-superconducting metals. We present a generalization, in the Eliashberg framework, of a BCS theory of superconductivity in good metals under thin film confinement. By numerically solving these new Eliashberg-type equations, we find the dependence of the superconducting critical temperature on the film thickness. This parameter free theory predicts a maximum increase in the critical temperature for a specific value of the film thickness, which is a function of the number of free carriers in the material. Exploiting this fact, we predict that ultra-thin films of gold, silver and copper of suitable thickness could be superconductors at low but experimentally accessible temperatures.
We demonstrate that this is a fine-tuning problem where the thickness must assume a very precise value, close to half a nanometer.

References

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